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NEW YORK, MAY, 1895.

EDITORIAL NOTES.

THE new interchange rules bid fair to become adopted, if it is any criterion to judge by the enthusiasm of those who have entered into the Chicago agreement. It is, of course, impossible to predict the recommendations that will be made to the June convention by the committee, and there will undoubtedly be a strong opposition to the throwing the responsibility for repairs upon owners, but the expense of maintaining the present system, and the continual friction that results from varied interpretations of the rules, will weigh strongly on the side of the party that is advocating the change.

IN a recent lecture before the students of Cornell University, Mr. Nixon, who was formerly Chief Constructor at Cramps, predicted that the United States was destined to become a great shipbuilding country, owing to its great ocean and lake coast, and regretted that the young men did not possess the opportunities that they should to pursue this important branch of industry. It does seem strange that, in view of the great advances which have been made in naval architecture in this country within what is almost the last decade, the colleges have not been prompt in establishing courses and endowing chairs for the naval courses.

THE reports of the runs that have been made by Admiral Meade's squadron of evolution in West Indian waters are most satisfactory to the friends of the new Navy. It appears that a maintained speed of 13 knots has been touched, which is 1 knot better than the previous performances of any squadron, while the claim is made that even a higher speed is possible. The reports also affirm that the "Pirates," the *Columbia* and *Minneapolis*, are able to hold their tactical distances easily while running at a speed of 16 knots. Such results are gratifying not only from the sense of having broken the record, but from the fact that the new Navy of the United States possesses the qualifications of speed and endurance that will render it most efficient when the occasion demands.

IT should be a matter of congratulation to those interested in technical education that the condition of affairs, as outlined by Professor Chaplin before the Engineers' Club of St. Louis, as existing in Germany has passed away in this country. It is not so very many years since the students pursuing a classical course in our colleges spoke with an air of half-pitying contempt of those taking a scientific course, as of an inferior grade of beings. But while the shoe may not be exactly upon the other foot, it does seem to be a fact that scientific courses and colleges are attracting wider public attention, and that the immediate work of these schools and colleges is considered of greater importance than that of the purely classical departments. The struggle between the two systems of education has been a long one, and the victory seems to be with the "scientifics." Doubtless the result will be the same in Germany.

OUR correspondent in Buenos Ayres writes that Captain Zalinski, who has been spending a month there and in Chili as the representative of the Bethlehem Iron Company, sailed recently on the French steamship *Portugal en route* for China and Japan. The Captain has been soliciting orders for guns and armor; and it has been particularly pleasing to Americans, and something of a revelation to the large English, French, and German contingent here, to see an American Company enter into competition with the European makers of this class of war material. Argentine field guns are Krupps and the naval (great guns) Krupp and Armstrong, most of the older ships having Armstrong's and the newer ones 4.72 in. and 6-in. Armstrong quick-firers, and when larger guns (like the 9.3-in. guns of the *Independencia* and *Libertad*) are used, Krupps. The Krupp wedge breech closure seems to be in favor here.

EIGHT-WHEELED COUPLED "GOODS" LOCOMOTIVE.

A RECENT number of *Engineering* contains engravings and a description—which are reproduced on another page—of one of the locomotives recently built by Messrs. Nielson & Co., of Glasgow, for the Mexican Railway, which recalls an acrimonious contention of forty years ago over the design of locomotives for freight service on the Baltimore & Ohio Railroad, which resembles the Mexican railway in having very long and steep grades and many sharp curves. At that time the standard freight locomotive on that line was Winans' "camel" engine, which had eight wheels coupled and no leading truck. About 1855 Mr. Henry Tyson was appointed Master of Machinery of that road, to succeed Mr. Samuel J. Hayes. Mr. Tyson was called upon to recommend a form of freight engine for service on that road. Both he and his predecessor, Mr. Hayes, had a predilection for leading trucks, and considered them essential for safety and for the prevention of undue wear to the track and flanges of the leading wheels. Mr. Winans was then engaged in the manufacture of locomotives in Baltimore, on what was then considered an extensive scale, and had supplied the Baltimore & Ohio Road with many of its engines. Naturally he was averse to having his design of engine abandoned and condemned. Besides he was of a contentious temperament,

which led him to attack Mr. Tyson's opinions and decision with a good deal of acrimony in the daily papers of Baltimore, and he endeavored to excite local popular feeling, as he said, in favor of home industries. Naturally the dispute attracted much attention from people who knew nothing about locomotives. At that time the erratic Zerah Colburn was publishing the *Railroad Advocate* in New York. There was also a draftsman named John Cochran, who at that time lived in Baltimore, whose enmity Winans had in some way incurred. He and Colburn joined hands against Winans, and the pages of the *Railroad Advocate* bristled each week with denunciations of Winans and his engines. The main question under dispute, as has been intimated, was whether a leading truck was essential for safety, and for resistance to wear of the rails and wheel-flanges. Winans was very wily and ingenious and resourceful in collecting statistics, illustrations, and demonstrations to support his opinions. At the same time, John Cochran and Colburn, in nearly every number of the *Railroad Advocate*, opened their controversial guns on Winans. In the mean while, Mr. Tyson quietly addressed letters to most of the master mechanics, road foremen, and some of the more intelligent locomotive runners on the road, asking their opinion of the relative merits of Winans's "camel" and the 10-wheeled engines which had been designed and built by Mr. Hayes and his predecessors, and which were at work on the road. As the whole weight of the camel engines rested on the eight driving-wheels, they, of course, had more adhesion than the 10-wheeled engines had, a portion of whose weight was carried on a four-wheeled leading truck. The camel engines, therefore, could pull heavier trains than the 10-wheelers. The reports of the men on the road in response to Mr. Tyson's inquiry were, however, almost unanimous in favor of 10-wheeled engines. The Board of Directors sustained Mr. Tyson, and the locomotives which were then built and ordered were 10-wheelers. It must be remembered that this was before the invention of the Bissel truck, and mogul and consolidation engines did not exist then. The 10-wheeled engines built from Mr. Tyson's designs were, however, never very successful, and had some serious defects, the weight being unequally distributed on the wheels. Later, however, the road continued to build 10-wheeled engines, until they were displaced by the consolidation type.

The engraving, which is reproduced on another page, of the locomotives for the Mexican road would indicate, however, that the questions involved in this old dispute are still undetermined, and that there is yet a great difference of opinion among engineers with the most abundant opportunity for getting information and experience with reference to the question, whether a leading truck is essential for six or eight-wheeled coupled locomotives. The Mexican line is now equipped with almost every variety of truck or bogie engines, including consolidations, Fairlie, and, we believe, Johnson's plan, and yet with this evidence before them those in authority have ordered the locomotives represented by the illustrations. It will be seen from these that the rear or trailing axle is under the fire-box, and the front wheels are placed as close to the back ends of the cylinders as possible; the latter, of course, overhanging the front wheels. The question which is of interest now, as it was away back in the fifties, is whether a truck or bogie to carry and guide the front end of the engine is or is not essential? If it is an unnecessary appendage, the machine would be both simplified and cheapened by abandoning its use. It cannot be repeated too often that the main purpose of locomotives is to draw trains, and the more trains they draw, the greater is their efficiency. This function is analogous to that of a reaping machine, the main object and use of which is to cut grain when it is ripe. No matter what other advantage such a machine may have, if it cannot gather the harvest at the right time it fails of its main purpose. So with a locomotive: if it is not capable for any reason to haul cars when they are ready to be hauled, it is to that extent a failure. The question comes up, then, whether a consolidation or 12-wheeled engine will haul more cars in the course of a year than a simple eight-wheeled engine, like those the Mexican Railway Company has ordered, which is not encumbered with a leading truck? When this question was discussed by Winans and his opponents, the decision was against Winans, and it was afterward concurred in by nearly all the railroad managers in the country; and since then no engines for road service have been built here without leading trucks. It would be a singular issue of this discussion, and of the years of experience which have intervened since then, if it should appear now that Winans was right, and that the designers and builders have been attaching to all freight locomotives a useless appendage in the form of a leading truck, and that the locomotives would be more efficient and would cost less if it were omitted. At any rate, the experience of the Mexican railroad with these engines is worthy of being studied, perhaps with profit to ourselves. It should be added that the decision which was reached with so much unanimity in this country was never concurred in by European engineers, and that a large majority of freight locomotives built and used on European railroads are without leading trucks.

There were also some other interesting questions involved in the dispute between Winans and Tyson. The valve-gear on the camel engines consisted of two eccentrics, with which the engine could be worked at full stroke either back or forward. The expansion gear consisted of a cam which cut off steam at about one-third of the stroke, in the forward motion only. Mr. Tyson advocated the use of a link-motion, which Winans condemned very bitterly. It is hardly necessary to say now which was right and which wrong, although it might be observed that within the past year so distinguished an engineer as Mr. Porter has proposed a cam with a fixed point of cut-off for stationary engines, so that it seems to be very difficult to be entirely certain about disputed mechanical questions.

Another feature which Winans advocated was the use of solid-end coupling-rods. Cochran and Colburn piled abuse and ridicule on this method of construction. In this it is now obvious that Winans was right and his opponents were wrong.

Another curious dispute grew out of the arrangement of Winans' engine frames and drawbars. The fire-boxes of the camel engines were made just as wide as the distance between the wheels would permit. The frames extended back only as far as the front of the fire-box. In order to connect the engine with the tender, a sort of A-shaped frame was made, which was attached to the bottom of the ash-pan, the two legs of the frame being bolted to the engine frames in front of the fire-box, and the apex was coupled to the tender drawbar back of the fire-box. This arrangement of course brought the drawbar very near to the top of the rails, and Mr. Tyson and Colburn asserted that the effect, when the engine was pulling, was to raise the back end up and thus throw more weight on the leading wheels. Winans asserted that if the drawbar was attached at a point or on a line coinciding with the top of the rails, that the tractive force of the engine would neither tend to raise nor depress the back end of the engine; or, in other words, that the neutral point or line was the top of the rails; whereas Tyson and Colburn contended that the centre of the driving-axle was the neutral line, and that the drawbar should be attached as nearly as possible in that position. We will not now say which we think was right, but will leave the question to our younger readers for discussion. It may be added, though, that this arrangement of draw-gear was miserably frail. The camel engines had a fire-box which sloped downward on top, which brought the furnace-door very low. The foot-board of the tender was made very low, so as to bring the fireman into a convenient position in relation to the

door. As the engine frames did not extend back of the front of the fire-box, there was nothing between the engine and tender to resist a concussion excepting this frail draw-gear. The foot-board and cab for the engineer was on top of the boiler, but the fireman was down behind the fire-box, where it was impossible to see impending danger. Many a poor and faithful fellow was crushed to death or, worse, was burned, scalded, or maimed in this horrible trap. The boilers, too, of the camel engines were criminally weak, and a great many of them exploded, but when this occurred, the engineer occupied the most dangerous position.

The student of locomotive design and construction will find a good deal that is interesting in the illustrations of the Mexican engines. There is nothing in the description or the drawings to indicate that the trailing wheels have end play, but the fact that the coupling-rods have spherical bearings where they are attached to the main crank-pins would suggest that the trailing axles have some lateral movement.

Another peculiarity is the tie-rods in the boiler. There is no end view to show how they are arranged, but it is inferred that they each occupy the space of one tube. The reason which led to the adoption of these rods was doubtless the difficulty of keeping the tubes from leaking. It would be interesting to know whether in this respect they are efficacious.

The valve-gear consists of an Allen straight link. Its use makes only a very slight bend of the lower eccentric-rod necessary, and not very much of a crook in the radius valve-rod where it passes over the leading axle. The distribution of steam with this form of gear is, we believe, equally as good as with other forms of link, and it has the advantages pointed out when applied to this type of engine. The valve-seat, it will be noticed, is placed vertically and on the side of the cylinder. The reluctance of English engineers to using a rocking-shaft, which would permit the valve-seat to be placed in the much more convenient position on top of the cylinders, is inexplicable to American designers. The argument against its use is, we believe, that it introduces an extra and superfluous part or organ. In reply to this it may be said that there is no working part of a locomotive which costs so little to maintain and repair as a rocker. We have no statistical data in support of the assertion, but it will probably be safe to say that the average cost of maintaining rocker-shafts in this country is not 25 cents for each per year. Then, too, we believe most American engineers would rather maintain a rocker-shaft than to lubricate and repair the sliding arrangement to which the valve-stem of the Mexican engines is attached, and which is shown in the drawings. In a rocker-shaft all the bearings are enclosed, whereas the Mexican slide is open at each end for the access of dust and escape of oil.

The plate frames and under-hung springs have advantages which we Americans are very slow to admit, but which are nevertheless obvious. In the engine illustrated they permit the fire-box to be made 6 or 8 in. wider than would be possible with our bar frames, unless the fire-box were placed on top, and then it would lose in depth.

One is disposed to wonder, though, why the "Gresham" sanding apparatus is placed in front of the main driving-wheels, and not in front of the leading wheels. With the arrangement shown only one half of the wheels are sanded.

It is hoped that after these engines get to work that the Superintendent of Machinery of the Mexican line will give the public full information of the results of their working. It will be especially interesting to know how the flanges of the leading wheels will stand service, and whether the engines are as safe and as little liable to derailment as other locomotives with trucks. If the flanges will stand the service, and if there is no more danger of derailment than there is when trucks are used, then the question may be asked, Of what good is a truck, anyway?

BOOKS RECEIVED.

MOTIVE POWERS AND THEIR PRACTICAL SELECTION. By Reginald Bolton. (New York: Longmans, Green & Co.)

CENTRAL AMERICAN RAINFALL. By Mark Walrod Harrington. Read before the Philosophical Society of Washington.

EIGHTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION. December 1, 1894. (Washington: Government Printing Office.)

INDICATOR DIAGRAMS AND ENGINE AND BOILER TESTING. By Charles Day. (Manchester: The Technical Publishing Company, Limited.)

SCREW PROPELLERS AND MARINE PROPULSION. By J. McKim Chase, M.E. First Edition. (New York: John Wiley & Sons, 1895.)

ANNUAL REPORT OF THE CITY ENGINEER OF THE CITY OF OMAHA. December 31, 1894. Andrew Rosewater, City Engineer. (Omaha: Klopp & Bartlett Company, Printers, 1895.)

TWENTY-SIXTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS of the State of Massachusetts. January, 1895. (Boston: Wright & Potter Printing Company, State Printers.)

PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS. Vol. XX. 1894. Edited by Captain C. B. Mayne, R.E. Royal Engineers' Institute. (Agents: W. & J. Mackay & Co., Chatham.)

A MANUAL OF INSTRUCTION FOR THE ECONOMICAL MANAGEMENT OF LOCOMOTIVES, for Locomotive Engineers and Firemen. By George H. Baker. (Chicago and New York: Rand, McNally & Co.)

POWER BRAKES *vs.* HAND BRAKES. A Paper Presented at the Annual Convention of the American Street Railway Association, Atlanta, Ga., by Edward J. Wessels, October 19, 1894. 29 pp., $5\frac{1}{2} \times 9$ in.

ANNUAL REPORT OF THE STATE BOARD OF ARBITRATION AND CONCILIATION, of the State of Massachusetts, for the Year ending December 31, 1894. (Boston: Wright & Potter Printing Company, State Printers.)

IMMIGRATION AND PASSENGER MOVEMENT AT PORTS OF THE UNITED STATES DURING THE YEAR ENDING JUNE 30, 1894. Report of the Chief of the Bureau of Statistics. (Washington, D. C.: Treasury Department.)

SEVENTH SPECIAL REPORT OF THE COMMISSIONER OF LABOR. *The Slums of Baltimore, Chicago, New York, and Philadelphia.* Prepared in Compliance with a Joint Resolution of the Congress of the United States, Approved July 20, 1892. By Carroll D. Wright, Commissioner of Labor. (Washington: Government Printing Office, 1894.)

PROCEEDINGS OF THE SECOND ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, held in Brooklyn, N. Y., August 20–22, 1894, in Conjunction with the American Association for the Advancement of Science. Vol. II. Edited by George F. Swain, Ira O. Baker, J. B. Johnson, Committee. (Columbia, Mo.: E. W. Stephens, Printer, 1895.)

TRADE CATALOGUES.

IN 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

IT seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues

hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.

STANDARDS:

For postal-card circulars.....	3¾ in. × 6½ in.
Pamphlets and trade catalogues.....	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter-paper.....	8½ in. × 10¾ in.

THE NICHOLSON FILE COMPANY, of Providence, R. I., have issued a smaller edition, 60 pp., 4½ × 6 in. [not standard size], of their larger catalogue, which was noticed in our March number.

THE GISHOLT MACHINE COMPANY, of Madison, Wis., send an eight-page circular, 5½ × 8 in. [not standard size], containing engravings and brief descriptions of their tool grinder and turret lathe.

THE D. VAN NOSTRAND COMPANY have issued a new catalogue of 64 pp., 5¾ × 6½ in. [not standard size], giving a list of books on Steam, Steam-Engines, Machinery, Mechanics, and Mechanical Engineering, which they publish and have for sale.

THE HURLBUT-ROGERS MACHINE COMPANY, of South Sudbury, Mass., send a four-page leaflet, 5¾ × 9½ in. [not standard size], describing and illustrating their cutting-off machines. The circular contains excellent wood-engravings of their machines.

THE SHORTT ENGINE COMPANY, of 143 Liberty Street, New York, publish a pamphlet of 12 pp., 4½ × 7½ in. [not standard size], in which a somewhat peculiar form of boiler and engine is described. It would be impossible to describe the construction of these without engravings so that they could be understood.

THE DE WITT WIRE CLOTH COMPANY, of 32 Reade Street, New York, send their price-list No. 54, which contains 24 pp., 3¾ × 6½ in. [not standard size], in which illustrations and prices are given of wire nettings of different kinds, wire fencing, gates, wire cables for lightning-rods and fencing, and wire cloth for various purposes.

CAST-IRON CHILLED CAR WHEELS. 37 pp., 4½ × 5¾ in. [not standard size]. This little publication is issued by the Association of Manufacturers of Chilled Car Wheels, and sets forth an account of the history and use of chilled wheels, and of the negotiations with the Master Car-Builders and Master Mechanics Associations, and the adoption of standard specifications and form of guarantee for cast-iron wheels.

PATENT STORAGE HEATERS FOR RAILWAY CARRIAGES. Illustrated Catalogue, with Detailed Explanation. W. S. Laycock, Victoria Street Works, Sheffield, and 91 Queen Victoria Street, London.

This pamphlet contains illustrations and descriptions of the Gold car-heater which Mr. Laycock is introducing on English roads. It requires no description here, as most of our readers are familiar with this system.

CATALOGUE NO. 3, RIEHLE BROTHERS TESTING MACHINE COMPANY, Philadelphia, 95 pp., 9⅛ × 12 in. [nearly a standard size]. This is a new edition of the catalogue published by this well-known Company, which has so long been engaged in the manufacture of testing machines. A great variety of them are described and illustrated. This new edition contains some additional matter which has been added to earlier catalogues and new names of parties using the machines of the Company.

THE ADAMS BOILER COMPANY, of Cleveland, O., have published a 12-page pamphlet, 5 × 8 in. [not standard size], describing the Adams feed-water heater and purifier, which is illustrated by two engravings, one an external and the other a sectional view. There are no letters of reference on these engravings nor in the description, so that the latter is not easy to understand. Of course, this deficiency in the catalogue does not imply that the heater and purifier is not all that it is represented to be.

THE PRINCE MANUFACTURING COMPANY, of 71 Maiden Lane, New York, have issued a pamphlet of 32 pp., 5¼ × 9 in. [not quite standard size], on The Rusting of Iron and Steel, How it May be Prevented and How it is Promoted, in which the virtues and merits of the Metallic Paint which this Company manufactures is set forth. An interesting feature is some engravings made from photographs showing black iron oxide scale produced by painting the hull of an iron steamboat with another kind of paint.

THE Q. & C. COMPANY, of Chicago, send us a catalogue of 24 pp., 6 × 9 in. [standard size], illustrating five different designs of cold metal-sawing machines and grinding machines for saw blades which they manufacture. These are illustrated with somewhat indifferent engravings, and are fully described. Probably, though, the efficiency of the saws will not be affected by the character of the engravings. The prospective buyer can get the information he wants from the publication before us, and that is what it was intended for.

MURRAY & TREGURTHA, of South Boston, Mass., have issued a catalogue of 40 pp., 5¼ × 9 in. [not standard size], in which the steam yachts and launches, Tregurtha water-tube boilers, single, compound, triple, and quadruple marine engines, propeller wheels, etc., are described. It is illustrated with a number of good wood-engravings and half-tone illustrations of their launches, boats, boilers, etc. The latter are described at considerable length, and their advantages set forth. A number of small vertical, simple, and compound engines, steam pumps, and engine and boiler attachments are also shown.

THE ST. LOUIS IRON & MACHINE WORKS send us two catalogues, both 5¾ × 8¾ in. [not standard size], one of them, of 42 pp., describing the St. Louis Corliss engine manufactured by this Company. Very good wood-engravings are given illustrating a simple, a tandem, a cross compound engine, and a "heavy duty" simple engine for rolling mills, etc. Detailed illustrations and descriptions are also given of the different parts of the engines, such as the pillow-block, cylinders, pistons, cross-heads, connecting-rods, fly-wheels, etc.

The second catalogue contains 23 pp., and describes the Improved Lion Brick Machine, which is built by this Company. A very simple form of slide-valve engine is also illustrated.

THE FIRE-PROOF BAKER CAR-HEATER. Manufactured by William C. Baker, 143 Liberty Street, New York.

This is an eight-page folder 8¼ × 10¾ in. [standard size], in which Mr. Baker's fire-proof car-heater of 1895 is illustrated by excellent wood-engravings. The heater is encased in a shell made of boiler steel capable of being bent and folded in close folds without cracking, as is shown by an illustration of sample which has been so treated. This shell is "firmly welded into one compact, jointless and seamless whole, which can be bent and buckled but never broken," and it is claimed that fire inside of it is as secure as it would be if enclosed in an express car safe. Further security is obtained by the use of sliding doors securely fastened, and by bolting the heater with strong bolts and brackets to the floor instead of fastening it with wood screws or not at all.

The Baker heater, as most of our readers will know, has a coil of pipe in the inside, through which water circulates and is carried through the car by pipes near the floor. This gives a uniform and very agreeable heat. Explosions are guarded against by the use of Mr. Baker's safety vent, which was illustrated in the AMERICAN ENGINEER for July, 1894, and is shown in the circular before us.

MORISON SUSPENSION FURNACES. Manufactured by the Continental Iron Works, Brooklyn, N. Y. 24 pp., 8¼ × 11 in. [Not standard size.]

The furnace which is described in this publication is similar to the well-known Fox corrugated furnace, which has been so extensively used in Europe and to a more limited extent in this country. The illustrations are a frontispiece on the title-page representing an external view of one of these furnaces; a full-sized section showing one of the corrugations; sectional views representing different types of the furnace method of flanging, arrangement in groups, etc.; and sectional views of land boilers, with single and double furnaces, and finally illustrations of the Morison patent furnace door and frame. A partial list of steamers to which Morison suspension furnaces have been applied occupies several pages of the book, which is well printed and illustrated. The deficiency in it is that the distinctive features of the Morison furnace are not fully enough explained. The reader, after finishing the description

on page 5, has no distinct idea of the difference between the old Fox furnace and the Morison form of construction, nor wherein the advantage of the latter consists. A fuller explanation of the objects aimed at and accomplished by the new form of furnace would, it is thought, make the book more useful to its readers and publisher.

The Ferracute Machine Company, of Bridgeton, N. J., have issued a new catalogue of their presses, dies, etc., which they make. The size of the cover of the catalogue is 7 × 10 in. [not standard size], and the leaves inside are of nearly double these dimensions, and have the peculiarity that they are all folded so as to be housed, as it were, inside of the cover. This gives a page 12¾ × 9¾ in. On the title-page it is stated that over 300 sizes and kinds of presses are described in the catalogue. These consist chiefly of presses and dies for the shearing, cutting, punching, bending, forming, embossing, coining, drawing, deepening, broaching, etc., of bar and sheet metals, together with paper, leather, cloth, and other materials. A few auxiliary tools, such as spinning lathes, beading machines, soldering apparatus, etc., are also made. The engravings are generally excellent wood-cuts, but there are also some half-tone engravings which are not so good, partly because they are not well printed. Blue ink is used, the reason for which is not apparent. It does not improve the appearance of the pages nor add to the effectiveness of the illustrations, and we are inclined to think is unsuited for half-tone work. Presses for doing a great variety of work are illustrated, and it would seem as though this Company was prepared to squeeze almost anything.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XIV.—METHOD OF DETERMINING FLASHING AND BURNING-POINTS OF COMBUSTIBLE LIQUIDS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(Copyright, 1891, by C. B. Dudley and F. N. Pease.)

(*Continued from page 75.*)

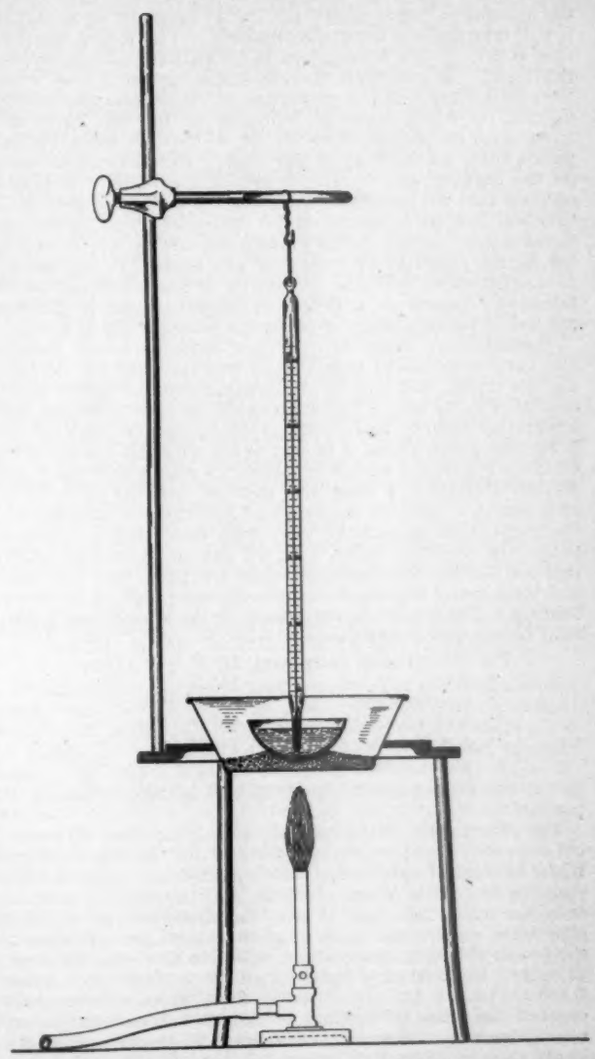
OPERATION.

Have ready the apparatus shown in the cut. Light the lamp, put it under the centre of the porcelain dish, adjust it as previous experience has indicated is necessary to secure the proper rate of heating, and allow the apparatus to get warm. Fill the porcelain dish to within about one-fourth of an inch of the top with the liquid to be tested, adjust the thermometer in the centre of the liquid, and so as to reach nearly to the bottom of it, but not quite touching the dish. Adjust the flame so that the temperature of the liquid in the dish rises at the rate required for the liquid being tested, and when the temperature reaches a desired point, apply the test flame by passing it slowly, entirely across the dish, about half an inch above the level of the liquid and just in front of the thermometer. Allow the liquid to rise in temperature until another testing point is reached, and then apply the test flame again in the same manner. Proceed in this way until the vapor from the liquid above it ignites with a slight flash. The temperature shown by the thermometer when this is the case is the flashing point of the liquid. Continue the heating and testing in the same manner until a point is reached where the liquid takes fire. The reading of the thermometer when this is the case is the burning-point of the liquid. Remove the thermometer, blow out the flame, or smother it by sliding a watch glass over the top of the porcelain dish, empty the dish and wipe it out, when the apparatus is ready for another test.

APPARATUS.

The principal portion of the apparatus required in determining the flashing and burning-points is shown in the cut. It consists, as is seen, of an iron tripod, fitted with a rod and clamp to sustain the thermometer, and supporting a small pan or dish partly filled with sand. On the sand and partly bedded in it is a royal Berlin porcelain dish about 2½ in. in diameter and 1 in. deep, to hold the liquid to be tested. Underneath the iron dish is a Bunsen burner to furnish heat. The thermometer may be any good chemical thermometer, but those with milk or paper scale, and graduated to single degrees, are easiest read.

The testing flame may be obtained in a variety of ways. A fine string or coarse thread was used for many years. This, when lighted, gives a bead of flame as large as a small pea. A glass tube drawn out to rather a fine jet and connected by a rubber hose with a gas supply is much better.



APPARATUS FOR DETERMINING THE FLASHING AND BURNING POINTS OF COMBUSTIBLE LIQUIDS.

The flow of gas can readily be adjusted to give a jet about ½ in. long and ⅛ in. in diameter, which is abundant in size. The glass tube fuses up sooner or later, and therefore best of all is a porcelain tube, such as is used with crucibles for ignition in hydrogen, attached by a rubber tube to a gas supply. The flame should be of the size given above.

NOTES AND PRECAUTIONS.

The philosophy of the method of taking flashing and burning-points of combustible liquids is simple. All liquids when heated to sufficient temperature give off vapors, the vapor being either a part of the liquid itself or the products of decomposition from it. Moreover, most liquids whose flashing and burning-points are desired, notably the petroleum products, contain some constituents which are volatile at lower temperatures and some which are volatile at higher temperatures, so that when heated by a constantly increasing temper-

ature vapors pass off in constantly greater amount. The process being conducted in the air, the vapors passing off from the liquid obviously mix with the air above it, and in course of time, if the heating is properly managed, a slightly explosive mixture of vapor and air exists just above the liquid. If, now, a flame is passed through this explosive mixture it is ignited, and a more or less violent explosion, or "flash," as it is called, follows. The lowest temperature at which enough vapor escapes from the liquid to form this explosive mixture is called the flashing-point of the liquid. In like manner, by continuing the heating and raising the temperature higher and higher, the amount of vapor issuing from the surface of the liquid becomes continually greater and greater, and the explosions become more and more frequent if the test flame is applied often enough, until finally the amount of vapor above the liquid becomes so great that it will take fire and burn continuously. The lowest temperature at which this takes place is called the burning-point of the liquid. It is obvious, therefore, that any conditions which have an influence on the generation of vapor from combustible liquids, or which have an influence on the mixing of this vapor with the surrounding air, or which influences its dissipation from the surface of the liquid, will have an influence on the flashing and burning-points of the liquid. It is also obvious that the apparatus used and the method of manipulation will have an influence on the figures obtained, so that the flashing and burning points of any given sample of combustible liquid, obtained by means of one apparatus and method of manipulation, will not necessarily be the same as that obtained by means of a different apparatus and a different method of manipulation, even on the same sample of liquid.

The condition which has the most influence on the flashing and burning-points of combustible liquids is the rate of heating the liquid, and this is at the same time the most difficult condition to control. The more rapid the rate of heating, the lower the flashing and burning-points, and in view of the principles given above, it is easy to see why this should be so. Obviously a liquid could be heated so slowly that the vapor formed would for a long time pass off into the air by diffusion, and the amount necessary to indicate the flashing and burning-points be obtained only with much higher temperature. On the other hand, a liquid can be heated so rapidly that the flashing and burning-points are practically the same, and these many degrees below the figures obtained by slower heating. The rate of heating used in the Pennsylvania Railroad Laboratory is as follows:

For 150° fire-test petroleum,	12° F. per minute.
" 300° " "	15° F. " "
" paraffine oil,	15° F. " "
" well oil,	15° F. " "
" 500° fire-test petroleum,	15° F. " "
" wood preservative,	12° F. " "

For all other combustible liquids of high burning-point, 15° F. per minute.

The adjustment of the rate of heating can best be learned by experience and constant watching of the thermometer. If the amount of sand in the dish is moderately large, and the temperature of the room constant, and the place where the tests are made free from drafts, the flame can be adjusted after some experience so as to give a close approximation to the required rise in temperature. But the thermometer must, of course, be constantly watched, and it is many times necessary to repeat a test even two or three times with readjustment of the flame on account of failure to secure the proper rate of heating. Moreover, each time the liquid is flashed a small amount of heat is generated, which affects the thermometer, and if the flashing is done very frequently this may be a very serious cause of disturbance of the rate of heating. The lower the flashing and burning points of the liquid being tested, the more difficult the manipulation to secure the required rate of heating.

In view of the difficulties introduced by frequent flashing, it is advisable to limit the number of times the test flame is applied as much as possible, and accordingly in the Pennsylvania Railroad Laboratory the test flame is first applied as follows:

For 150° fire-test petroleum,	at 123° F.
" 300° " "	" 242° F.
" paraffine oil,	" 291° F.
" well oil,	" 243° F.
" 500° fire-test petroleum,	" 487° F.
" wood preservative,	" 165° F.

In all cases after the first the test flame is applied after each 7° rise in temperature, until the burning-point is reached. This is in accordance with an old law of the State of Pennsylvania, enacted in the early days of the petroleum industry.

The method of applying the test flame has an important influence. By skilfully and adroitly passing the test flame down alongside the thermometer to within $\frac{1}{4}$ in. of the liquid and quickly pulling it out again, considerably higher figures may be obtained for the flashing and burning-points than with the manipulation specified. Apparently near the centre of the dish, alongside the thermometer, the air and vapor are not as well mixed, or at least are not in condition to ignite as readily as at the side of the dish. By the prescribed manipulation the chances for juggling with the results are diminished, since the test flame passes twice through that part of the mixture of vapor and air which is most readily ignited—namely, the part at the edges of the dish.

It is impossible to make satisfactory tests for flashing and burning-points in a place subject to drafts.

Among the variables affecting the flashing and burning-points of combustible liquids, which are made constants by the apparatus specified above, may be mentioned the amount of surface exposed, the depth of liquid in the dish, and the total amount of liquid. Any or all of these being different, the same figures would not be expected, even though the manipulation was in every respect as specified. Moreover, a difference of an inch or more in the barometric pressure, which might readily occur in different parts of the country, would also have an influence on the figures obtained, the lower barometer giving the lower figures.

It is well known that thermometers change with use, especially if they are not well seasoned before going into service. It is essential, therefore, to occasionally compare with a standard, or to use new thermometers.

Occasionally an anomalous low fire-test petroleum product will be found. The flashing and burning-points are very close together, whatever the rate of heating. Apparently the liquid is very closely fractionated, or is made up of constituents differing very slightly in vaporizing point, and consequently its behavior does not conform to that characteristic of liquids having a wider range of constituents.

It is fair to say that open-cup testing of combustible liquids, even when all possible precautions are taken, is subject to some uncertainties. Duplicate tests with the same liquid, the same apparatus, and the same manipulator may disagree one point, or 7°, and an attempt to get duplicate figures, representing the flashing and burning-points of a liquid as close as 1 or 2° F., would probably result in failure.

ELECTRIC WEED-KILLER.

Mr. A. A. Sharp has been experimenting for sometime with an electric weed-killer for railroad work. In reply to inquiries we have received the following letter from the electrician in charge of the technical development of the apparatus

Editor of The American Engineer and Railroad Journal

I beg to state that the apparatus used by us consists of an alternating generator mounted on a car and producing electricity at 2,000 volts pressure and stepped up to from 6,000 to 24,000 volts, depending on the kind and quality of the vegetation which we wish to destroy.

The conductivity of vegetable bodies varies as the moisture within them varies; the greater the moisture, the less resistance they offer to the current. The current, after being stepped up to the voltage noted, is conducted through a series of fine wire or brush to the top of the weeds or grass; the other side of the circuit is made through the wheels of the car as a matter of course to the ground; the current, therefore, will leap from the brush suspended over the weeds through the weeds to the ground, and thus complete the circuit; but in doing so the current traverses the entire length of the plant, including the roots, and ruptures the cellular tissues, thereby totally destroying it. This destruction seems to be equally distributed throughout the entire system, the root suffering perhaps more than the body of it from the fact that the roots generally contain more moisture. In many cases the current, in passing through the plant, heats it to such an extent that it cannot be held in the hand without discomfort.

The device is entirely practical; and I am satisfied that Captain Sharp has made a discovery which will be of infinite value in connection with the destruction of noxious weeds, the Canadian and Russian thistle, cockle burrs and the like. It is especially valuable in the destruction of plants such as the thistle, where the root itself must be destroyed in order to annihilate the weed.

The device is of great value in the destruction of grass and weeds along the railroad, where the maintenance of the right of way is decreased to the extent of from $40 to $80 per year

per mile; and I believe, in connection with the work of exterminating the Russian thistle and such like noxious weeds, it will prove to be of great benefit.

The apparatus can be made quickly and at no very great expense. During the coming summer there will be ample chance for you to see the machine in practical operation, and it would give the writer great pleasure to have you accompany us on one of our trips. I trust this will give you some insight into the application of this machine.

CHARLES G. ARMSTRONG.

ELECTRIC MOTORS AT THE SOUTHWARK FOUNDRY & MACHINE COMPANY'S SHOPS.

WHILE the discussions relative to the advisability of using electric motors for driving machine tools has been in progress, and while the comparative merits of the *pros* and *cons* have not been settled, the Southwark Foundry & Machine Company have found by stress of circumstances that it has been almost necessary for them to adopt an extensive system of electric motor driving for doing a wide range of work in their shops. It is well known that the specialty of this establishment consists in the construction of what is known under the general name of heavy work. This work covers so wide a range that none, or at least very little of it, can be done by tools built especially for the purpose, and they are, therefore, compelled to depend upon the ordinary standard tools to execute it.

As the handling and setting of this work would involve a great amount of labor were it to be carried to the machine, it has been found to be more economical in many instances to carry the machine to the work, and for this purpose a number of small machines have been designed and built that can be clamped to the work, the latter really acting as the bedplate for the tool. Besides greatly facilitating the work, this method possesses the further advantage of enabling certain parts, such as bedplates of engines and the like, to be cast in one piece; whereas, were it necessary to do the machine work upon some regularly appointed tool in the shop, it might be necessary to cast it in two or more pieces that it might be brought within the range of the capacity of that tool, besides requiring more machine work to be done in order to fit the two parts together.

As the adaptability of the electric motor to this class of work was demonstrated to be a success, it was applied to other fixed tools in the machine shop, where there is a very heavy four-headed planer, built by the William Sellers Company, driven by an individual motor, and beside it there is a large facing miller driven in the same manner. In the case of the latter, the advantages derived from the use of the motor are very apparent. The head and all of the machinery, including the motor, travels over the ways, while the work is bolted to a heavy bedplate and is stationary. A fixed screw in the base beneath the head is the point to which the power for propulsion is applied. As the motor is bolted to a bracket on the head or frame of the machine, it has been unnecessary to make any provision for the variation of the point of application of the power, and the single belt that covers with its many bendings all of the pulleys to which motion must be imparted, suffices. This machine is used for facing wide surfaces, such as the feet of engine frames, and is, of course, far more rapid in the execution of its work than a planer.

The erecting shop is also equipped with two 50-ton electric cranes that are in constant service, handling not only the heavy work itself, but lending efficient aid in the setting and adjustment of the portable tools, which are sometimes very heavy in themselves. Indeed, one of the portable machines was not built for portability, but is an exceedingly well and substantially built radial drill that is at times hoisted to the top of large machinery in course of erection, and, driven by an electric motor, is made to do its work, while, were it bolted to a suitable foundation on the floor, it would be absolutely impossible to utilize it for this class of operations.

Among the almost innumerable applications of these motors, we can only mention a few of the more noteworthy and prominent. At the present time there are in course of erection at the shops four triple-expansion engines for the Philadelphia Water Works. As the parts of these engines are exceedingly heavy and bulky, portable machines have been used for doing a large portion of the heavier work; the main crank bearings on the bedplate have been bored out by a specially designed boring bar driven by an electric motor; the cranks are bored for the pins by a boring machine clamped to the body of the crank-shaft and driven by a motor on the floor; a great deal of slotting is done by special slotting devices, while it goes without saying that all of the drilling on the heavier portions is done by portable drills that are driven by individual motors, this having been found to be more expeditious and convenient than the old-fashioned rope drive with which all are familiar. In the case of these engines, too, the motor is utilized for driving a train of gearing by means of which the engines are turned over after erection for the purposes of valve setting and such other work as may require this to be done. In fact, the impression obtained is that small tools are amply sufficient for performing the major portion of the machine work on these very large jobs.

There is still another general application that is easily imitated, and one which, we believe, will meet with a cordial reception; it is a lathe-grinding tool. The trouble with all lathe-grinding attachments that have been heretofore in use is that the length of the overhead drum limits the length that can be ground, and determines the exact place where it must be done. At the Southwark shops the emery wheel fixture is bolted to the lathe carriage in the ordinary way; a couple of pieces of timber are also bolted on and left to project out to the front 5 or 6 ft. The motor is placed on these and belted direct to the wheel shaft. So the power travels with the carriage, the drum is entirely dispensed with, and the work can be done at any point along the length of the bed.

Hydraulic jacks, crank presses, valve bushing insertions are all operated by these portable machines, and, indeed, it would be difficult to mention an application which it has not found.

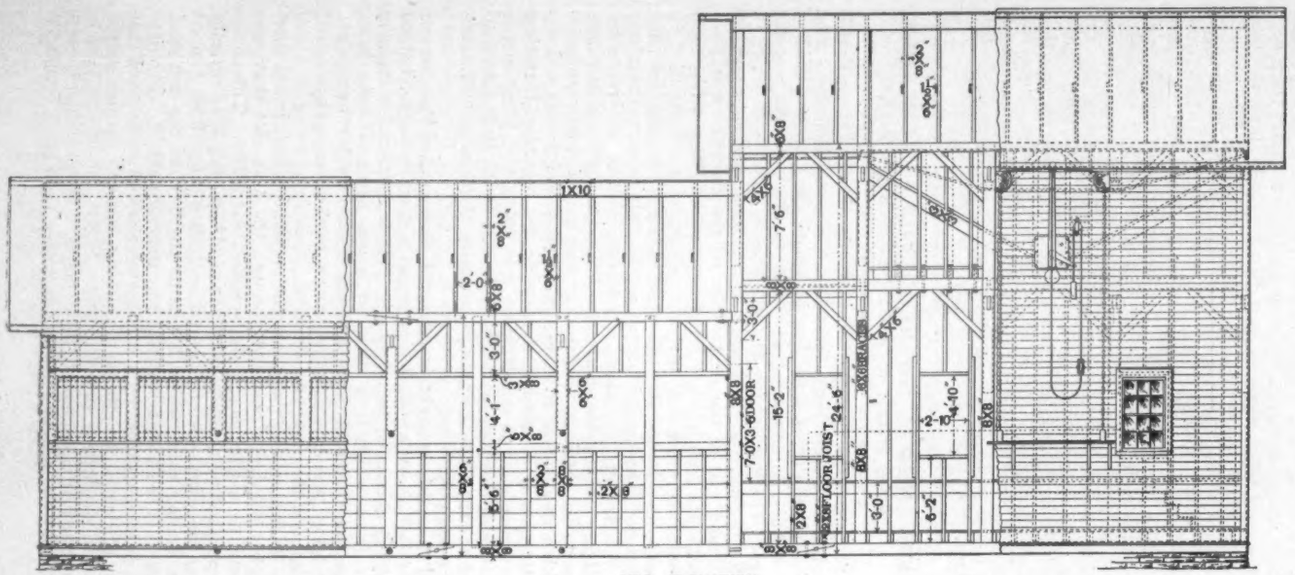
The motors used average about 3 H.P. and are connected by insulated wires strung to switches located at convenient points about the shop. No pains are taken to fasten the motors while they are at work, as their own weight is amply sufficient to hold them in position and keep the belt tight. The unfortunate part of the matter is that the installation is, like the Irishman's wife, regarded as a "rale convanyence," without any reference as to cost of maintenance. There are no figures available under this head. The power for the dynamo is taken from the main line of shafting, and so goes in with the general cost of power, without the slightest attempt being made or being likely to be made to separate it. The reason is very simple: the motors work so satisfactorily and effect such evident savings in the cost of manufacturing that even though their efficiency might be found to be below the lowest figures that any one would presume to give them, the savings would still be found to be far in excess of any wastefulness in the consumption of power that they might be found to develop.

SAND SHED AT HORNELLSVILLE—NEW YORK, LAKE ERIE & WESTERN RAILROAD.

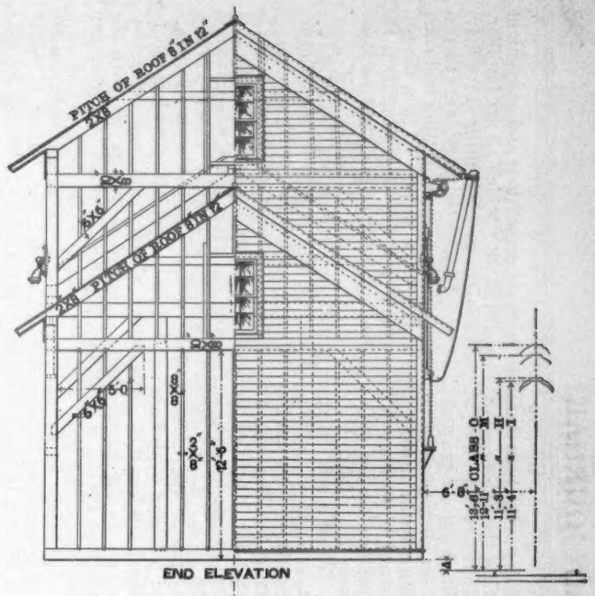
SOME months ago there was completed at the Hornellsville shops of the New York, Lake Erie & Western Railroad a sand storage and drying shed that is remarkably complete in all of its details, an engraving of which is given on the opposite page. The total length of the whole building is 70 ft., 40 ft. being utilized for the storage of wet sand, and shown at the left-hand end of the engravings of the elevation and plan. It consists merely of a large covered building with doors opening between the uprights, placed at a height of 6 ft. above the sills, and through which the sand is unloaded from the cars. The main building at the right is devoted entirely to the drying, elevating, and storing of the sand ready for delivery to the locomotives. While the officers modestly assert that the sand shed proper was not originally designed with a view to the most modern methods of drying and elevating sand, it certainly appears to the lay mind that they have succeeded in constructing a building and plant that is admirably adapted to the purpose for which it is intended, and one that handles a large quantity of material with economy and ease.

The sand is brought in from the storage shed by means of a trolley, from which is suspended a hopper-shaped bucket holding about 400 lbs. of sand. This is filled and brought to the dryer, where it is raised by means of an air-hoist to an elevation above the dryer, and put upon a track running over the latter, and on which the bucket can be run to any desired point over the dryer and dumped.

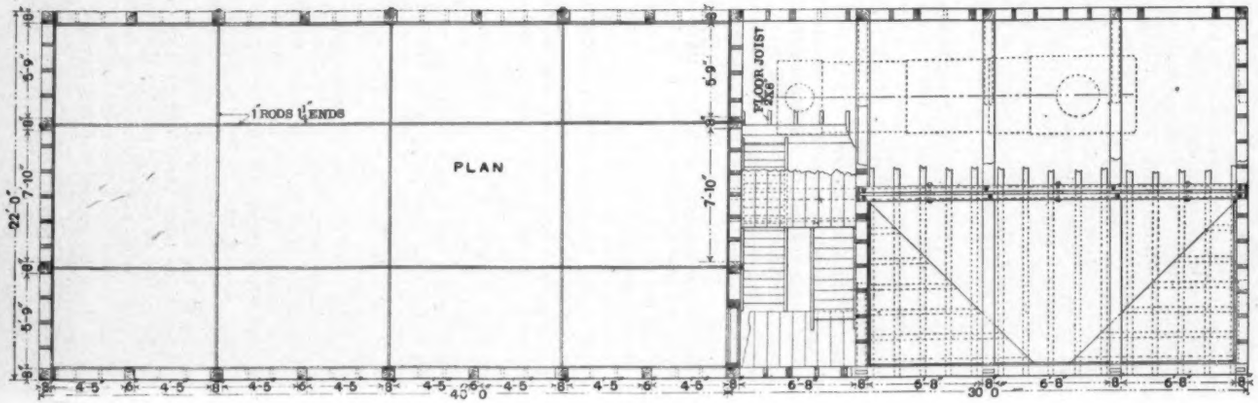
The dryer is so designed that no sand which is not thoroughly dried can pass out through the ¼-in. slot that runs along the entire length of its lowest extremity. This is accomplished by means of a convex shield that is placed directly over the lowest steam-pipe and extends out to within ¾ in. of the sloping sides, where it retards the flow of the wet sand until it is dried sufficiently to run over this shield. The drying is accomplished by a number of rows of steam-pipes that run the entire length of the drying bin and furnish ample heat to thoroughly dry the sand. Steam for this purpose is furnished by a locomotive form boiler, whose location is indicated by the dotted lines in the lower right-hand corner of

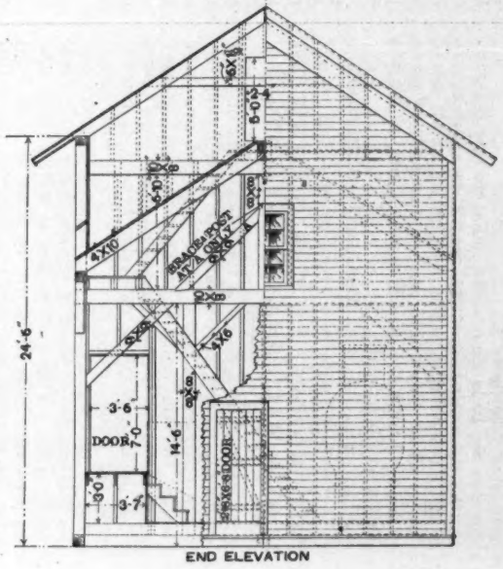


SIDE ELEVATION



END ELEVATION





END ELEVATION

SAND-SHED AT HORNELLSVILLE—NEW YORK, LAKE ERIE & WESTERN RAILROAD.

one of the end elevations. It also provides the steam for an 8-in. Westinghouse air-pump, which in turn provides the compressed air for elevating the dried sand.

When the dried sand runs down through the slot it first passes through a fine screen, which is stretched over the sloping channel, and is then carried by gravity down into the mouth of a funnel, whence it passes directly into a blast-pipe, and is blown by the current of air coming from the air-pump into the storage bins above. In order that the amount of sand elevated may be regulated in proportion to that required, the portion below the bins is divided into three sections, each having its own independent hopper and pipe. This also enables one of the pipes to be shut down for repairs without stopping the whole plant or disturbing either of the others. When this is done the air pressure is increased in the two remaining sections, and nearly as much work is done with the two at such times as with the three when working under the normal pressure of 25 lbs. per square inch, showing that the actual capacity of the plant is considerably above that at which it is rated, which is an average of 14 tons of sand per day dried, and elevated to the storage bins, or enough to supply from 60 to 70 locomotives.

The storage bins into which the dry sand is elevated are at a sufficient height, so that it will flow into the sand-boxes of the locomotives by gravity. The upper end elevation of the building shows the line of rails running alongside the building with the heights of the tops of the sand-boxes of several of the classes of locomotives that are in use upon the road. A spout like that ordinarily used for water enables the fireman to take on sand in exactly the same way that he usually fills the tank with water and with a minimum of time, while the cost for labor is practically reduced to nothing.

Referring to the details of the sand-bin as shown in figs. 1 and 2 they will require but a brief explanation. In fig. 1 is seen a side and end elevation with a plan and cross-section of the threefold dryer. This dryer is 20 ft. long, and occupies half the length of the drying portion of the building. The sand, after being dried by the heat of the steam pipes as already described, drops through the slot in the bottom, and running down the inclines, flows into the funnel *B* through the strainer netting *C*. This latter is made of wire with six meshes to the inch, and is readily taken out for cleaning. The funnel *B* is made of galvanized iron, and is of the dimensions given in fig. 2. The action of the air blast will be easily understood by referring to the end elevation in fig. 1. The sand flows out of the bottom of the funnel *B* and through the curved pipe into a tee, into the bottom of which the air nozzle *A* is screwed. Here it meets the air blast and is carried up the 1¼-in. discharge pipe to the hopper above.

The section *E* in fig. 2 is drawn through the outlet from the storage bin. The section shows the disk valve open for the

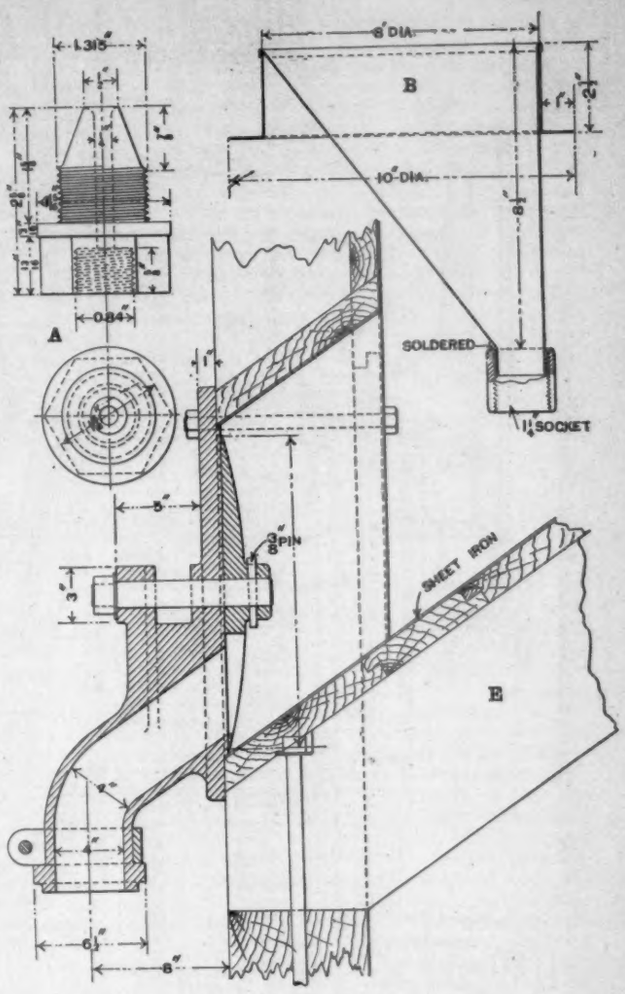


Fig. 2.

DETAILS OF HORNELLSVILLE SAND-SHED—NEW YORK, LAKE ERIE & WESTERN RAILROAD.

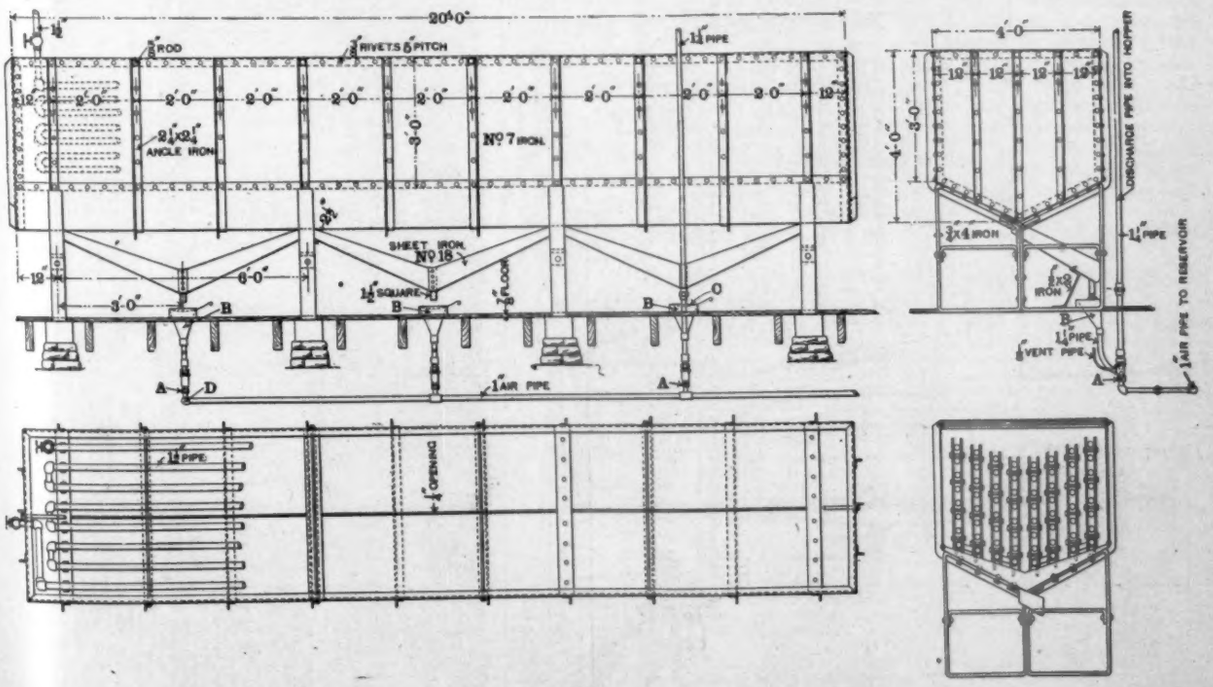
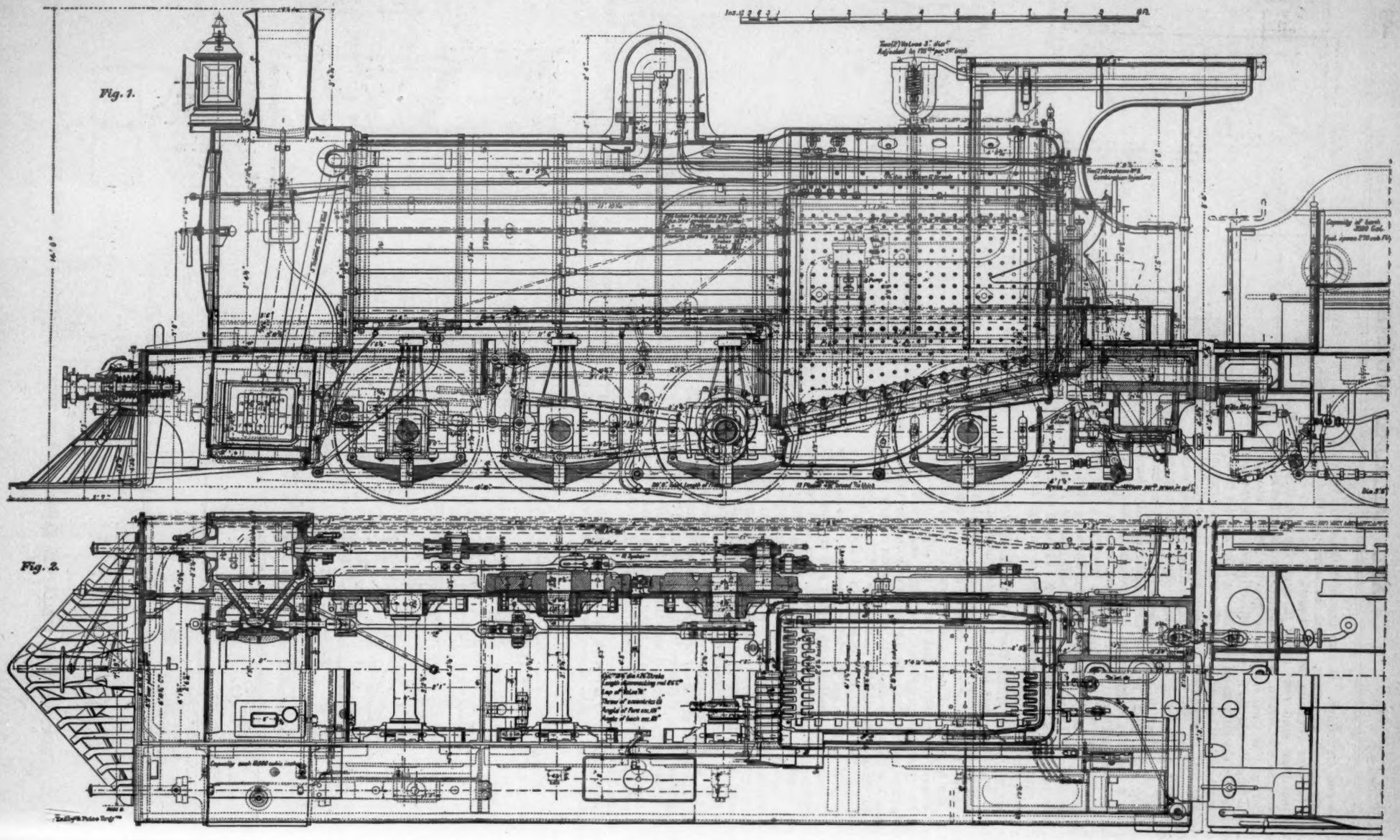


Fig. 1.

SAND-DRYER, HORNELLSVILLE SAND-SHED—NEW YORK, LAKE ERIE & WESTERN RAILROAD.



EIGHT-WHEELED COUPLED FREIGHT LOCOMOTIVE FOR THE MEXICAN RAILWAY.

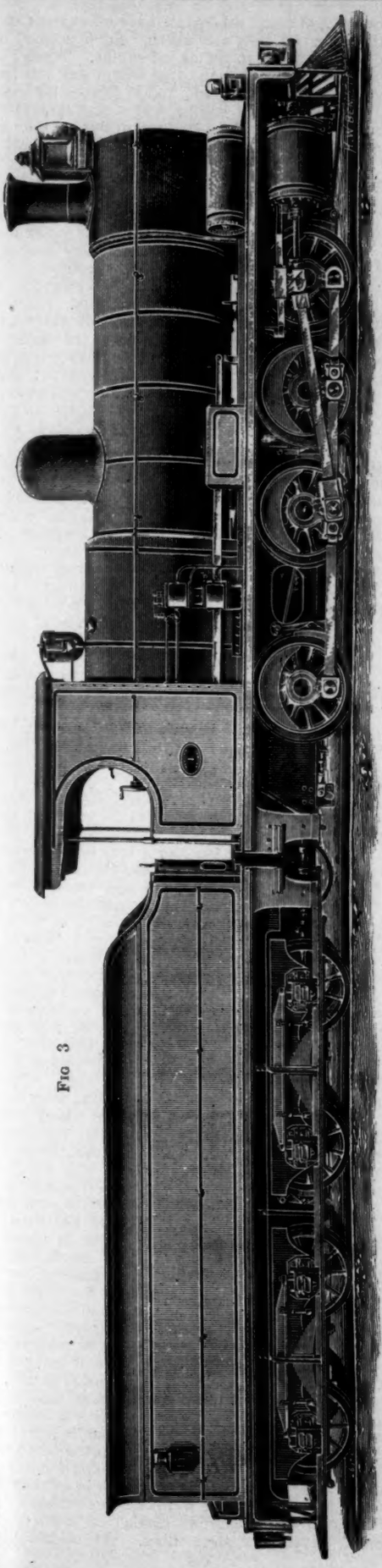


FIG 3 EIGHT-WHEELED COUPLED FREIGHT LOCOMOTIVE FOR THE MEXICAN RAILWAY.

flow of sand, but a pull upon the lever attached to the stem of the same in the opening shown in the casting on the outside of the building will give the valve a quarter turn and shut off the flow of sand. All working parts are readily accessible for repairs, and their dimensions are fully given on the engravings.

The whole plant is so complete and must effect such a marked saving, not only in the amount of sand used, but in the cost of labor in handling and drying, that it cannot fail to commend itself to all superintendents of motive power and master mechanics whose divisions employ locomotives enough to warrant the original outlay, which, in the case of so simple a structure as this, seems to have been reduced to a minimum. The only point of criticism which can be offered is the use of the Westinghouse pump for air compressing, which no one claims to be an economical steam user. The substitution of a regular compressor might effect a slight saving of coal, but in view of the familiarity of railroad employés with this pump, and the naturalness with which an extra one is slipped into any convenient nook where it can be used, the criticism will necessarily be without much force. The main fact is that the plant is exceedingly convenient and economical.

FREIGHT ENGINE FOR THE MEXICAN RAILWAY

In the accompanying illustrations we show one of the freight engines built by Messrs. Nelson & Co., of the Hyde Park Locomotive Works, Glasgow, for the Mexican Railway, the specifications being prepared by Sir A. M. Rendel, the Consulting Engineer for the line. The service that the locomotive will be called upon to perform will be over many miles of track where the gradient is steeper than 1 in 30; hence even a light train necessitates the use of a powerful engine. The engine illustrated has cylinders 18½ in. in diameter and 26 in. stroke. The wheels, which are eight-coupled, are, however, but 4 ft. in diameter over treads, so that the tractive force is very high. Unlike the passenger locomotives that are in use on this line, there is no bogie, but the second pair of driving-wheels are unprovided with flanges, thus easing the engine around the stiff curves which are of such frequent occurrence on the line. The cylinders, it will be seen, are almost horizontal, and the pistons are provided with tail-rods, which work in gun-metal casings bolted to the front cylinder covers. Allan's straight link-motion has been adopted, the valves being balanced. The guides, it will be seen, are of the single-bar type. The boiler barrel is 5 ft. in diameter inside and 11 ft. 6 in. long. The fire-box is also of ample dimensions, being 7 ft. 4½ in. long and 3 ft. 6½ in. wide, inside dimensions. The grate is of the American finger type, the bars being rocked from the foot-plate when necessary for cleaning purposes. It has, it will be seen, a considerable slope, which greatly facilitates the stoking of such a long grate. The crown is stayed direct from the outer fire-box. The working pressure is 165 lbs. per square inch. The brake gear has been supplied by the American Westinghouse Company, and Walker's regulating blast-pipe and the Gresham steam sander have also been applied. The latter must prove very useful on the heavy grades. The lubricating arrangements are, it will be seen, very complete, care having been taken to facilitate the work as much as possible.

The tender is the same as for the passenger engines on the line.

The principal dimensions and particulars of the locomotive are as follows:

Gauge of railway	4 ft. 8½ in.
Diameter of cylinders	18½ in.
Length of stroke	26 in.
Diameter of wheels	4 ft.
Wheel base	15 ft. 6 in.
Mean diameter of boiler	5 ft. 1¼ in.
Length of boiler	11 ft. 6 in.
Length of fire-box casing	8 ft.
Number of tubes	286
Diameter of tubes	1¾ in.
Heating surface in tubes	1,664 sq. ft.
" " " fire-box	147 sq. ft.
Total heating surface	1,811 sq. ft.
Area of grate	25 sq. ft.

	Tons.	Cwt.
Weight on leading wheels	13	4
" " second leading wheels	14	11
" " driving-wheels	14	13
" " trailing-wheels	13	8
Total	55	16

Tender the same as for passenger engines.

Wheel base of engine and tender	44 ft. 1 in.
Weight of engine and tender in working order	99 tons, 4 cwt.

—*Engineering.*

MEETING OF MECHANICAL ENGINEERS.

GAS ENGINES.

MR. EMERSON MCMILLAN, who was introduced by Secretary Hutton, presided. The subject for the evening was Gas Engines, the discussion of which wso opened by Mr. Reeves. The general purport of his remarks were that gas engines afforded a very convenient means for the subdivision and transmission of power, and that "gas plant would be incomparably more economical than that of compressed air or the electrical or the hydraulic system of transmission of power." The speaker stated further as a "hypothesis," which he hoped to hear discussed, that the near future will see the distribution of energy—all energy—which is derived from coal in the form of a non luminous, cheaply produced fuel gas; that this gas will be relied on entirely for power, for lighting when gas lighting at all is permissible, and when it is not, where the electric lighting is needed, that electric light will be produced through the medium of gas engines, and that this same gas will be used for all sorts of fuel and heating purposes."

Mr. Reeves took a good many more words to say this than we have quoted. He was followed by Mr. Burchard, who read a long and tedious paper of much prolixity which fatigued his audience. In the language of a distinguished physicist, the limit of mental elasticity of his audience was "overpassed" by the strain imposed on it by the paper. While the audience was endeavoring to recover from its permanent set the Secretary read a discussion communicated by Professor William S. Aldrich, of West Virginia University. He spoke of the advantages possessed by gas engines for the distribution of power, their arrangement and the possibility of using "rotary" engines, and the difficulty of regulating the speed of any gas engine, and suggested that tests of such engines were very much needed.

Mr. Richmond was called in and said:

"Mr. Chairman, you are not correct in announcing the fact that we have been making experiments in gas engines. We had need of a motive power for small refrigerating machines in connection with the Delavergne refrigerating machinery, and we started out to find a suitable motor for running those machines, and the first thing that suggested itself was a gas engine, naturally. Well, we thought it would be a good thing to build those gas engines so that we might get all the benefit, and after a little while we were assailed by a number of inventors of gas engines who came to us with propositions something like this: We build the gas engine, and we put about 300 per cent. upon the cost and we divide up on the proceeds between us. (*Laughter*). It seems to me that the gas-engine business is in a rather unhealthy condition in this country at the present moment. Undoubtedly the owners or the licensees of the Otto patents had a very good thing while it lasted, and that rather excited the cupidity of outsiders, and they were prepared, as soon as the Otto patents ran out, to build gas engines at any price they could be sold at and realize an immense fortune for everybody concerned in the matter. I have catalogues, I think, from something like thirty different builders of gas and gasoline engines in this country. It would be hardly fair to quote their prices, but I will tell you that I got as much as 40 per cent. discount quoted at the first slap. I don't know how much I could get by negotiation. (*Laughter*). So it seemed to us that there was very little prospect of dividing up any 200 or 300 per cent. profit. As a matter of fact, the prices are all broken up in the gas engine at the present moment. The subject this evening, of course, has turned on the larger-sized engines used in producer gas, and really my experience is not relevant to that. Nevertheless, as you have called on me, it would be well perhaps to explain my experience. During the summer I was in Europe and looked into this subject of gas engines, and at a very early period I found out that in Europe the gas engine seems to be a back number—I speak of smaller powers, up to 50 H.P.—and in its place they are using oil engines. I was quite taken with the subject. In fact, when I came back I represented to our company that it was quite a good business, and I procured five or six—not gas engines, but oil engines—representing the various different systems of vaporizing oil and using it in an engine, and it is not gas engines that we have been experimenting with. I thought that was quite a revelation. I thought it was very clever to arrive at the conclusion ahead of anybody in America that the oil engine was the coming thing. But when I looked into that again I was not quite so proud of my achievement. It seemed rather extraordinary that American manufacturers were ignorant of the fact that all the makers in Europe were busy with oil engines. I am an Englishman myself, as probably you can guess; and all the familiar names of makers of steam engines, such as Hornsby, Robey, Howard and many others, all have oil engines and are pushing them for all they are worth. So it seemed to me that all we had to do was to get an oil engine. When I came to inquire a little further I found that where gas was too expensive people were using gasoline, and in Europe the gasoline engine had preceded the oil engine, and it was promptly put aside as soon as the oil engine had been developed—by an oil engine I mean an engine using a heavy oil, one flashing at about 100° flash point. These engines will use oil at 100°, 150°, or even 300°. On making further inquiries I found that the oil-engine men had been busy here, and the manufacturers had been busy looking into it and they had not adopted it. So far as I can see the only reason is that where gas is too expensive the people use gasoline. Now, in Europe they cannot use gasoline in the cities because it is absolutely prohibited by the insurance companies. In this country there seems to be some means of conciliating all the different interests. (*Laughter.*) I understand that it is managed something in this way: A man who wants a gasoline engine applies to the authorities, and for a certain consideration he gets a license as a grocer to sell gasoline, and he sells gasoline to himself (*laughter*), and he finds it a very good business, and he runs his gasoline engine. Now, these gasoline engines are sold for what they can get for them—that is to say, that when I take the price-lists in Europe—and they assure me that they can get the price they put on the list with a very slight reduction—I find the gasoline engines are sold at about half the price they are getting in Europe for the oil engines. That first struck me as probably the reason why the American manufacturer is not so ready to take up the oil engine. Nevertheless, I am certainly of the opinion that the oil engine is the engine of the future.

"Now, instead of occupying your time talking about the oil engine, I would like to introduce, Mr. Chairman, a gentleman who came with me—Mr. Wildy, who is a member of the English Institute of Mechanical Engineers and also of the German Society, and who represents Hornsby & Sons, of Grantham, and they claim to have the best oil engine. He has something to say about oil engines, and he can speak with much better authority than I can with the little experience I have had."

The Chairman: We would be glad to introduce Mr. Wildy if he will walk forward where the members may see him.

Mr. W. Lawrence Wildy then stepped to the platform and spoke as follows:

"Mr. Chairman and gentlemen, when I came in here tonight I had no idea that I was going to do anything except listen to the paper of our friend, and I have listened to it with a great deal of interest. I have had a very considerable experience with producer gas, water gas and the ordinary gas in use in engines that is in England, and the figures which he has given to-night I can pretty fully substantiate, only I wish he had gone a little bit further into the question of the actual method of producing the gas in the producer. Most of you know, doubtless, that the producer is an ordinary cylindrical vessel lined with fire-brick and more or less intricate in shape according to the inventor's idea of what his patent is (*laughter*) and with certain cooling surfaces or heating surfaces or conducting surfaces or something; but you will find 150,000 patents in the patent journal doubtless, and they have all got something about them. But the simplest producer I have ever used was a column of fuel about 10 ft. high. The fuel we used in England was coke—the coke which, after the distillation of the gaseous product, was a residue which went to make the cost of the production of gas a mere cipher to the corporation running that gas concern. In Leeds, where I had my experience principally, the gas which was distributed through the houses cost nothing in the holder—it was all profit. (*Laughter.*) I have seen the figures, and I have gone into it with the Chairman of the Gas Committee of the Leeds corporation, and it is a fact that it was a decimal short of nothing in the holder. (*Laughter and applause.*) You laugh, but I am telling you the facts. The by-products from making the bituminous gas were so valuable at that time that they paid all the expense, interest and depreciation of plant, and the gas in the holder cost nothing but distribution and collection of accounts. Metres, of course, are charged by rent there. In proportion to the size of our metre they charge us 18 pence or half a crown or two shillings, so that does enter into consideration, and inside our premises our pipes are all our own, so that the distribution costs from a shilling to 14 pence per day according to the district, and we get good gas, 16 candle-power gas, which, with the Welsbach light, would give us the best part of 50 with a 3-ft. consumption. We get gas supplied for 10 pence per 1000 ft. and 5 per cent. discount for cash in quarterly account. But at the same time we were using enormous quantities of gas for a process which we carried on in our works; that was for the welding of steel tubes. We made tubes of

varying diameter, from 20 in. to 60 in., and these varied in thickness from $\frac{5}{16}$ in. to $\frac{1}{4}$ in., and we welded these with the ordinary coal gas, and our gas bill ran from £6,000 to £7,000 a year, and it came to a pretty heavy item. I got hold of this water-gas process as it was made in Germany at the time, and I saw that it seemed a very good heating medium, very cheaply produced, and we went in for a plant there. The plant was a magnificent success so far as we were concerned. It reduced our gas bill from between £6,000 and £7,000 to just over £1,000 a year—fuel, interest, depreciation, labor, distribution, everything concerned, came over just £1,000 a year, or something under one-sixth of what we paid before. That gas cost us on an average about threepence halfpenny per 1,000 cub. ft. We made only water gas; but we got no by-products, and therefore it cost us nothing in the holder. In the water-gas business there are no by-products. You simply consume your fuel right away there in the blowing-up process or in the cooling-down process, wherein you inject steam and produce carbonic acid first of all at the top, dissociating the water into its constituent parts of carbonic acid and hydrogen. That carbonic acid in going down to a lower temperature parts with its atom of oxygen and absorbs an atom of carbon and becomes carbonic oxide, and that passes to the scrubber, where it is cleaned, and then to the holder. That was the gas with which we reduced our expenses from £6,000 to £1,000 a year. We went further than that by experiment, and after we had made our water gas, which took us for a period of about 10 minutes, we used to blow the generator hot for 10 minutes with a pressure of air of 16 in. or 17 in. water column. We then shut the air off from the bottom, shut the steam in at the top, blew down through that and produced water gas. But that water gas was produced for only a period of four minutes. After that they began to get an amount of carbonic acid in the gas which would have cost too much to remove, and therefore we thought four minutes sufficient. After the four minutes' blow we turned our valves the other way, and we went on producing hydrogen and carbonic acid, and then took the carbonic acid out and got pure hydrogen. We used this in water gas. The ordinary producer gas which we used in our Siemens furnaces for the production of steel plates was produced in a somewhat similar manner, only it was continuous. There we had a cylindrical column of fuel about 4 ft. in diameter and 12 ft. high, and at the bottom of it what we call a trumpet pipe, a pipe that was trumpet-mouthed at the top, and into that came a jet of steam. This jet of steam, at 60 lbs. pressure blowing into the pipe, introduced a strong current of air, so that we got about 8 in. of pressure below the fire, for there were no bars. The fire was simply carried on a brick column of fire-brick, but it left an annulus around this column through which the air could pass by. With that producer we got a gas which gave us 30 per cent. of carbonic oxide and 5, 6, or 7 per cent. of hydrogen and a very small percentage of the olefiant gases which were hardly valuable. After that we went in for other experimental business, and came on to the oil engine which was the subject that Mr. Richmond has kindly fastened on to me to-night. In the oil engine we have a machine which works with the ordinary petroleum of commerce—that is, any of the lighting oils which are in the market. It will also work with the heavier oils up to the specific gravity of .9, and it will work with an oil having a flash point of anything that the ordinary oils have and up to 320° F. Now, an oil of 320° F. is a pretty strong oil. The process through which this oil goes to produce its power is as follows: The engine is provided at the back of the cylinder with a small cylindrical chamber which we call the vaporizer. On to this vaporizer is fixed a valve chamber which really holds two valves and which are the governor valves of the engine; the one opens inward to the vaporizer, the other opens by the action of the governor outward, and through a small pipe conveys any oil which is not required back into the tank from which the pump has drawn it. The rest of the construction of the engine, so far as its communicating the power imparted to it is concerned, is almost identical with the gas engine—a trunk piston and connecting-rod and crank shaft; on the crank shaft a pair of skew wheels, the skew wheels driving a lay shaft—almost identical again with the gas engine—which lay shaft communicates motion, first to the governors and then to two valves, one for the air inlet and the other for the exhaust; the air inlet cam at the same time operates a small pump from $\frac{3}{8}$ in. to $1\frac{1}{2}$ in. in diameter according to the power of the engine to be developed, and this pump has a stroke which can be adjusted by the regulation of the screw—that is, the oil pump—so that the amount of oil which is injected into the vaporizer is exactly in proportion to the power the engine requires. Suppose you are running the engine at half power, you run the pump at half stroke; if you are running the engine at full power, you run the pump at full stroke—that is, if you know you are going to do so. But if you are running the engine at full power and throw off half the machine, the governor will do that; but the effect will not be so perfect as if you, knowing what you want, reduce it yourself. The exhaust valve has a double cam very similar to the gas engine, by which a portion of the compression can be released when starting the engine. Now, in operating the engine you begin by heating the vaporizer with a lamp, an ordinary paraffine lamp with a circular wick to which a small fan is attached, producing for the time being a little petroleum forge. It takes 5 to 10 minutes to heat that vaporizer. The only process is to fill the lamp and turn the fan-handle. As soon as it is hot enough it is knocked by a cock on the cylinder, and you can turn your fly-wheel and your engine goes off at full cock; it is ready immediately, and it goes off at full power then and there, governing itself as the governors dictate. The governing is brought about by the distention of the governor balls acting on a lever which depresses the second valve that I spoke about in the little valve chamber on the vaporizer, so that the oil which is pumped up and which is in constant supply is rejected from the vaporizer—never allowed to enter it, because the first valve has a slight spring on it of an ounce to the square inch, and if the upper valve is open you can readily realize that as there is an escape to the oil it will not even open with that an ounce to the square inch, so that the power lost is enough to pump a good deal less than half a thimbleful of oil and return it to the vaporizer. Immediately on starting the lamp goes out. By that I mean that we have got to such a gauge that the lamps, if properly filled, will run just long enough to heat the vaporizer to the right temperature, and will be burned out at that time. In England, when our experts go out to teach anybody there to start engines, they say to the men, 'You just work that handle gently until that lamp goes out.' We have no lamp, we have no tube, we have no electricity, but the continual combustion of the oil in the vaporizer restores to the vaporizer the heat which has been extracted by the vaporization of the oil and the heating of the air necessary to produce the subsequent explosion. These engines have been running continuously for two months, day and night, without stopping, without any hitch whatever, and the higher the work that is taken out of the engine up to full power, the better the engine works. At very low powers the engine will want a little nursing perhaps, but at full power she will work right along. We start our engine at 5.30 in the morning, and the men come in at six o'clock, and she is never looked at again except when the man goes in at dinner-time and oils her, and at half-past five when he goes to stop her, and there is no outside flame, no exposed red heat or dangerous flame of any sort about the engine.

A Member: What do you mean by nursing?

Mr. Wildy: I mean this: that if the engine has to run light for five or six hours—which I suppose no sane man would do under ordinary circumstances—it is possible that he may want to put a little brake on to the engine, or something of that sort—to put a little work on her.

Mr. Holloway: Is there any residuum in the cylinder?

Mr. Wildy: None whatever. We have run her for two months, and there is not as much as you could wipe off with your hand.

Mr. Oberlin Smith: What was the efficiency of the various sizes in fuel per H.P. hour, rating the oil at the same price as coal?

Mr. Wildy: I can hardly give you that here. The consumption runs about $\frac{1}{2}$ of a pint of American Daylight or Water White per H.P. on all sizes of engines. It runs a little lower, but only a little lower, on the larger engines than on the smaller ones. The very small ones will run to a pint. There is a greater loss owing to the friction of the engine itself. I am giving you per brake H.P. in that case, not I.H.P. We sell the engine on the power which the purchaser is going to get off the fly wheel. He doesn't care what the power is in the cylinder. He wants what he will get off the fly-wheel. A 16-H.P. engine uses just .8 of a pint.

The Chairman: Mr. Burchard, yours uses about a pound of carbon?

Mr. Burchard: Yes, sir, about a pound of carbon in the gas.

The Chairman: A pint weighs about a pound. Your $\frac{1}{2}$ Imperial would weigh about a pound?

Mr. Wildy: Yes, that is so, sir. In Russia they are adopting these engines, and we cannot keep pace with them. With us in England it is a matter of consideration, because the oil, which, I understand, you give about 7 cents a gallon for, costs us about sixpence halfpenny a gallon. They are doing wonderfully well with the engines over there. Every class of power user is adopting them to the rejection of all steam engines up to 50 or 60 H.P. They are in the hands of stablemen, gardeners, coachmen, all sorts of people who, after they are once instructed, know what to do.

Mr. Perry: How about the noise from the explosion? Is it less than from the gas engine?

Mr. Wildy: The pressures in the oil engine are rather lower. In the Scotch gas I have had as much as 210 lbs. initial pressure in the gas engine. The consequence is that the terminal pressure is so high that the exhaust end becomes noisy. What is your engine pressure? (*To Mr. Burchard.*)

Mr. Burchard: About 180 lbs.

Mr. Oberlin Smith: About what is the price of this engine compared with engines of like power, after the 40 per cent. is taken off?

Mr. Wildy: I am afraid you have got on the wrong track. Mr. Richmond was not alluding to our engine. We do not do business that way in this country.

Mr. Oberlin Smith: We want to get the 300 per cent.

Mr. Wildy: Three hundred per cent.—that is nearer the mark. I am much obliged to you, gentlemen.

Dr. Emery: I think we are all grateful to the gentleman for his very complete description of the apparatus. But I would like to ask a question which has occurred to me. I cannot see how you can pump the air into a hot chamber and let part of it run out without some danger of explosion. I suppose that the stroke of the pump is timed so as to put that into the chamber at the proper time.

Mr. Wildy: That is a matter that I evidently missed. The fact is, that the oil is injected into the cylinder on the outward stroke of the piston while it is drawing air in, and if the governor at that moment says, "You shall not have any more oil," it rejects the remainder of the oil, the back pressure closes, and the rest of the oil goes back into the tank. The oil which has gone into the vaporizer has gone in at a period of suction. I dare say if we could get a very light scale in the indicator we could show very low vacuum there.

Dr. Emery: Where does it go—the oil? Does it go first into the cylinder or into the hot chamber?

Mr. Wildy: Into the hot chamber. It never goes into the cylinder. The explosion only goes into the cylinder. The hot chamber is a little Stilton cheese joined on to the main cylinder by a small rectangular neck, so that only a very small proportion of the vapor oil ever gets into the cylinder until the compression stroke comes on, and at that point, owing to the compression and the temperature of the vaporizer, the explosion takes place and the impulse is given to the engine, and it is by that particular arrangement of adjusting to each engine the exact capacity, the vaporizer and the temperature of the vaporizer, that we get our explosion just at the right moment. Unfortunately I have not any diagram with me.

Mr. Jesse Smith: What maintains the temperature of the generator?

Mr. Wildy: The continual combustion of the oil.

Mr. Smith: Whereabouts?

Mr. Wildy: In the vaporizer. There is no generator. It is nothing but a vaporizer.

Mr. Smith: There is a fire inside?

Mr. Wildy: No, sir, there is no fire inside. It is such a black heat that it would only just melt tin.

Mr. Smith: What maintains that temperature?

Mr. Wildy: The combustion of the oil.

Mr. Smith: But the combustion takes place in the cylinder of the engine.

Mr. Wildy: No, sir; it takes place in this vaporizer and communicates by this little narrow neck.

In answer to a question by the Chairman, Mr. Wildy said further:

"With gas at two shillings per 1,000 ft. we run rather cheaper with the oil even at sixpence halfpenny. The gas-engine makers will tell you that they use 14, 16, 18 cub. ft. to the H.P. As a matter of fact, they will use 25 to 30 cub. ft. in regular work. But with the producer gas you will use at the very least 90 to 100 cub. ft. of gas, and then you have always to provide an attendant to the producer and the steam boiler, and you have got a great deal more plant to put down for that gas engine than the oil engine. When you come to take into consideration the depreciation on the first cost and labor, you get a cheaper engine with the oil engine than with the producing gas engine."

A Member: What causes the explosion in the vaporizer?

Mr. Wildy: The temperature of the vaporizer and the compression of the mixture. There is no electric spark, no flame, no ignition tube. There is nothing after you have once started the engine but the temperature of the vaporizer. If there is any gentleman who doubts at all what I am saying to-night, if he will visit the Delavergne Company's works, where they have got one of these engines, Mr. Richmond will be only too pleased to let him see that engine running, and show him that there is nothing whatever but the temperature of the vaporizer and the compression to produce that. To prove to you that it is the compression, we use a different amount of compression for American oil from what we use for Russian oil, and the engines are all adapted, so that you can make an engine here to-day and use it on Daylight oil, and send it to Russia to-morrow, and by altering it in a little matter which will take perhaps seven minutes you can use it with Russian oil. The Russian oil requires 25 to 30 per cent. more compression than the American oil.

The Chairman: Have you determined the temperature of the ignition there with the power you are running at?

Mr. Wildy: It does not matter what the temperature is provided it is not below 400°. We find that at 400°—the melting point of tin—we could start any engine with any oil.

Mr. Holloway: As we understand it, the oil lies in the vaporizer until the compression raises the temperature.

Mr. Wildy: No, sir. The instant it is in the vaporizer it is vapor because our vaporizer is at black red heat. The compression will increase the temperature a little, of course, but it will not be a very great matter. We put a block of tin on there; the moment that melts that is the proper point to start the engine.

Then followed a desultory discussion of no special value, with which the evening closed.

The next meeting will be held on the evening of May 8, when Mr. F. W. Dean will read a paper on the Efficiency of the Compound Locomotive.

NOTES AND NEWS.

Electric Light Unreliable.—The Midland Railway of England has been forced to abandon the electric lighting system, with which several of its trains have been equipped, on account of its unreliability and expensiveness. The trains will hereafter be illuminated by Pintsch gas. The electric system furnished a beautiful light; but unfortunately the efforts of the mechanical department of the road to perfect it sufficiently to meet the requirements of the service were unavailing.

Stay-bolt Broken at Two Places.—The engravings, figs. 1, 2 and 3, represent a stay-bolt sent to us by Mr. David Holtz, of the Western Maryland Railroad, which, as shown, when taken out of the boiler was broken at both *A* and *B*. Fig. 2 is an end view of the fracture at *A*, and fig. 3 a similar view at *B*. The bolt was screwed into the plate and was broken at *B*, the portion remaining in the plate not being shown.

A B

Fig. 1.

Fig. 2.

Fig. 3.

STAY-BOLT BROKEN IN TWO PLACES.

This break was an old one, and complete. The fracture at *A*, however, was not entirely complete when it was taken out of the boiler, a small area of bright, freshly broken metal being shown just above the centre in fig. 2. It is difficult to assign any satisfactory cause for these two breakages. Have any of our readers observed similar instances?

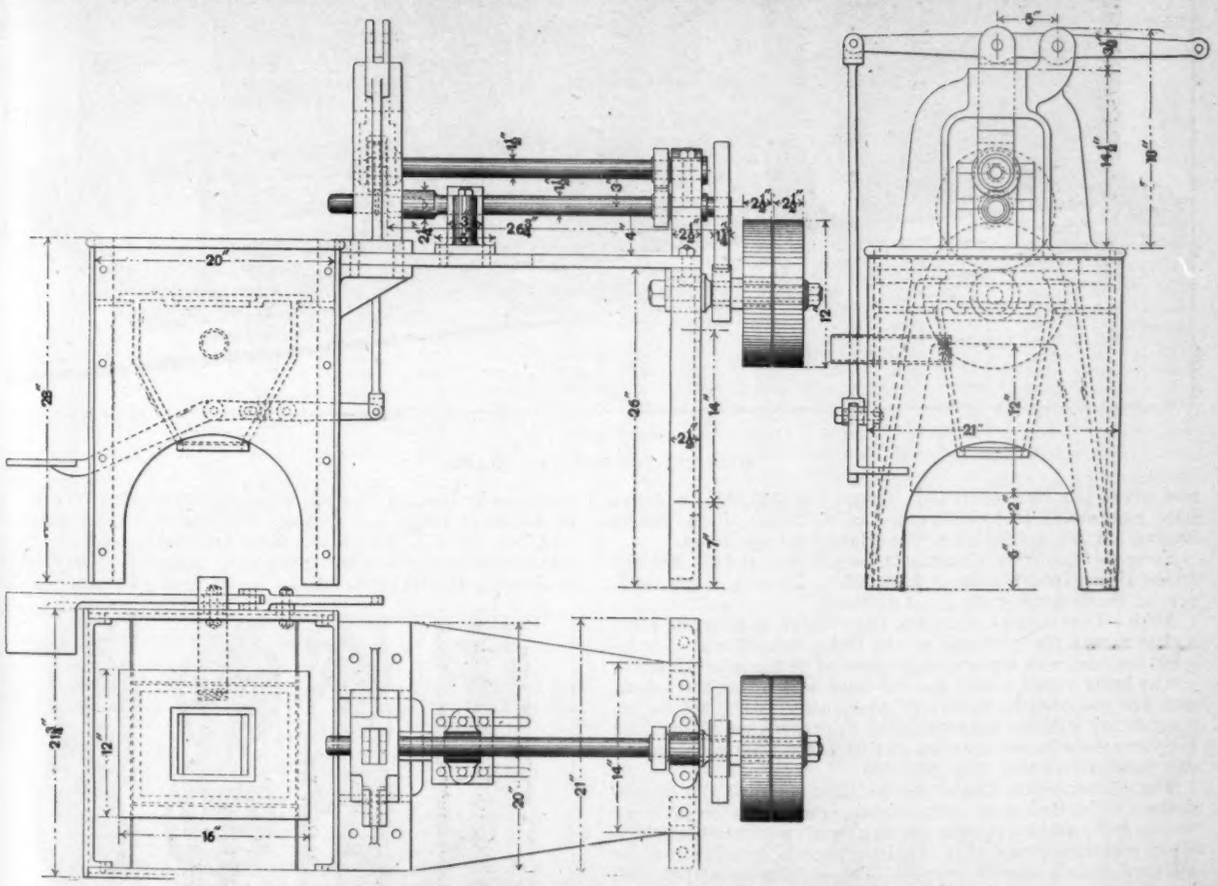
Aerial Tramway over Niagara.—A bill, it is reported, has been sent to Albany, and will be introduced into the Legislature, authorizing a company to erect a tower and landing place in the State Reservation Park for a scheme which all right-minded people ought to condemn. The company proposes to carry tourists across the Niagara River over the brink of the cataract and 30 ft. above the raging waters. A double set of cables will be stretched from the towers in the Canadian and American parks, with a supporting tower on Goat Island. On these cables cage-like cars will be suspended by trolleys and operated by electricity from the American side. The aerial line will follow along the brink of the American Falls to Goat Island, and thence to the Canadian shore, form-

ing a cord to the bow of the Horse Shoe Falls. The floors of the cars will be perforated to allow visitors to look below, and the side views will also be unobstructed. It gives one a desire to perforate the bodies of the projectors of this scheme merely to read about it. Are there to be no places on earth exempt from the invasion of the trolley?

Rack-rail Roads.—According to *The Engineer* there are up to the present time 19 railways using the Abt system, with a total length of 207.55 miles, of which 105.77 miles are supplied with rack-rail. Fourteen of these railways are in Europe, two in South America, one in Japan, one in the West Indies, and one in Manitou & Pike's Peak Railway, in the United States. The *Indian Engineer* says that in addition to this 26 railways using the "Ladder" or Marsh rack have been built. These have a total length of 100.59 miles, partly rack and partly adhesion, of which 21 are in Europe, two in Brazil, one in Sumatra, and two in the United States—viz., the Mt. Washington Railway and the Mt. Desert Railway.

that the masters' association shall cause to be paid to the men such arrears of pay as have been withheld from them, under the agreement, whether with the consent of the men or otherwise; that Mr. Rees was at liberty to employ or discharge such men as he deemed fit, and that he therefore be not called upon to reinstate all or any of them, but that the men displaced should not be put to any disadvantage in obtaining employment. It is also recommended that in future differences the negotiations should be confined to the authorized officials of the two societies.

Tube-Beading Machine, Philadelphia & Reading Railroad.—Among the special tools that have been built at the shops of the Philadelphia & Reading Railroad, at Reading, Pa., for use at that point, is the tube-beading machine illustrated in the accompanying engraving. The tubes are beaded down at the fire-box end to take a copper ferrule, and expanded a trifle at the smoke-box end to avoid too much rolling out. Formerly the beading was done so as to form a shoulder, but



TUBE-BEADING MACHINE, READING SHOPS, PHILADELPHIA & READING RAILROAD.

Practicable Arbitration.—The following account of the way in which a dispute between men and their employers was settled in Liverpool will indicate the beneficent results of arbitration when each side is disposed to deal fairly with the other, and when each is represented by intelligent and just arbitrators:

For some days in January a carters' strike had been imminent in Liverpool, as a consequence of a dispute between the Liverpool Cartowners' Association (Limited) and the Mersey Quay and Railway Carters' Union. It was feared that the trade of the port would be greatly hampered, the union carters numbering about 3,000. The dispute arose out of an alleged breach by Mr. Joseph Rees, an employer, of an agreement entered into in 1892 between the two organizations in regard to payment for overtime. The men gave a week's notice, to terminate on Saturday last. In the mean time, as a result of negotiations, it was agreed to refer the points at issue to arbitration. Messrs. George H. Cox (Vice-Chairman of the Liverpool Board of Conciliation) and William Chadwick were the arbitrators selected, and the Lord Mayor of Liverpool acted as umpire. The finding of this tribunal was announced by the Lord Mayor at the Town Hall on Saturday to the secretaries of the disputing organizations. The award is to the effect that the agreement has not been strictly adhered to;

this practice has been abandoned. The engraving illustrates both the forge in which the tubes are heated and the beading machine. The latter stands directly back of the fire, and is driven by a 2-in. belt running on the pulleys shown at the rear. By following the lever action from the treadle at the front of the forge to the application of the pressure on the tube it will be found that a very heavy downward pressure is brought to bear upon the tube, which is slipped over the lower mandril, by the roller on the upper shaft. When the tube has been heated the workman simply slips it over the lower mandril, bears down on the treadle, and in a few turns the beading is finished. A similar machine is used at another forge for welding the ends on to tubes.

The New Torpedo-Boats.—The Naval Construction Board, consisting of Chief Constructor Hichborn, Engineer-in-Chief Melville, and Commodores Sampson and Chadwick, which has under consideration the various bids opened February 19 for three sea-going torpedo-boats, has made five alternate recommendations to Secretary Herbert, as follows:

First—All three boats might be awarded to the Columbian Iron Works, Baltimore, at their bid of $97,500 each for the three boats.

Second—Two to the same company at their bid of $103,000

each, and the other to the Union Iron Works, San Francisco, at $135,000.

Third—Two to the Columbian Iron Works at $103,000 each and one to the Herreshoffs of Newport at $113,850, the latter boat guaranteed to have a speed of 25 knots, all the others having but 24½, according to the original specifications.

Fourth—One to the Columbian Iron Works at $107,000, one to the Union Iron Works at $135,000, and one to Hugh Ramsey, of Perth Amboy, N. J., at $126,000.

Fifth—Two to the Columbian Iron Works at $103,000 each, and to accept the proposal of the Union Iron Works to build a 240-ton boat with a guaranteed speed of 28 knots for $243,000.

The latter vessel would be 100 tons larger than the others, and her completion, including equipment, could not be accomplished without exceeding the appropriation allowed for the three vessels, the amount available for their construction and equipment being only $450,000.

The Construction Board decided that none of the special designs submitted to the department, some of which involved bronze hulls and aluminum bracing, were worthy of consideration, and determined that the departmental specifications for all steel vessels should prevail. The supplemental bid filed last Saturday from the Herreshoffs, guaranteeing a 25-knot boat, will probably be among those accepted.

Machine-Rolled Chains.—Mr. J. C. Monaghan, the United States Consul at Chemnitz, has sent in a report to the State Department regarding the machine for rolling chains. We reproduce the engravings accompanying the report, and the report itself in full:

"A recent invention of rolls for making chains seems destined to revolutionize the whole trade of iron and steel-chain making. It does away with the welded joint and secures uniformity, rapidity, and increased strength in construction. It was brought to my attention during an investigation of tin rolling. The new machine resembles somewhat the machine or roll that sinks impressions in hot or steamed wood—*i.e.*, its mode of working is similar. There is, first of all, the roll (fig. 1), and, second, a peculiarly formed bar of iron (fig. 2). The rolls are four in number, and are so situated and so arranged that they work simultaneously on the curiously formed iron bar, cutting it into links. A glance at fig. 1 will reveal much more of the *modus operandi* than any description in words would do. The curves that look like chain links are the highly tempered—*i.e.*, hardened, steel dies or cutters. The gears fit into each other and operate simultaneously on the four flanges of the iron bar. At a point just back of the cross—that is, in front of the gears of fig. 1—the projecting cutters of the gears almost meet. Through this point passes the iron or steel bar at white heat. The gears revolve rapidly, turning out 3 to 4 yds. of chain per second. The iron bar

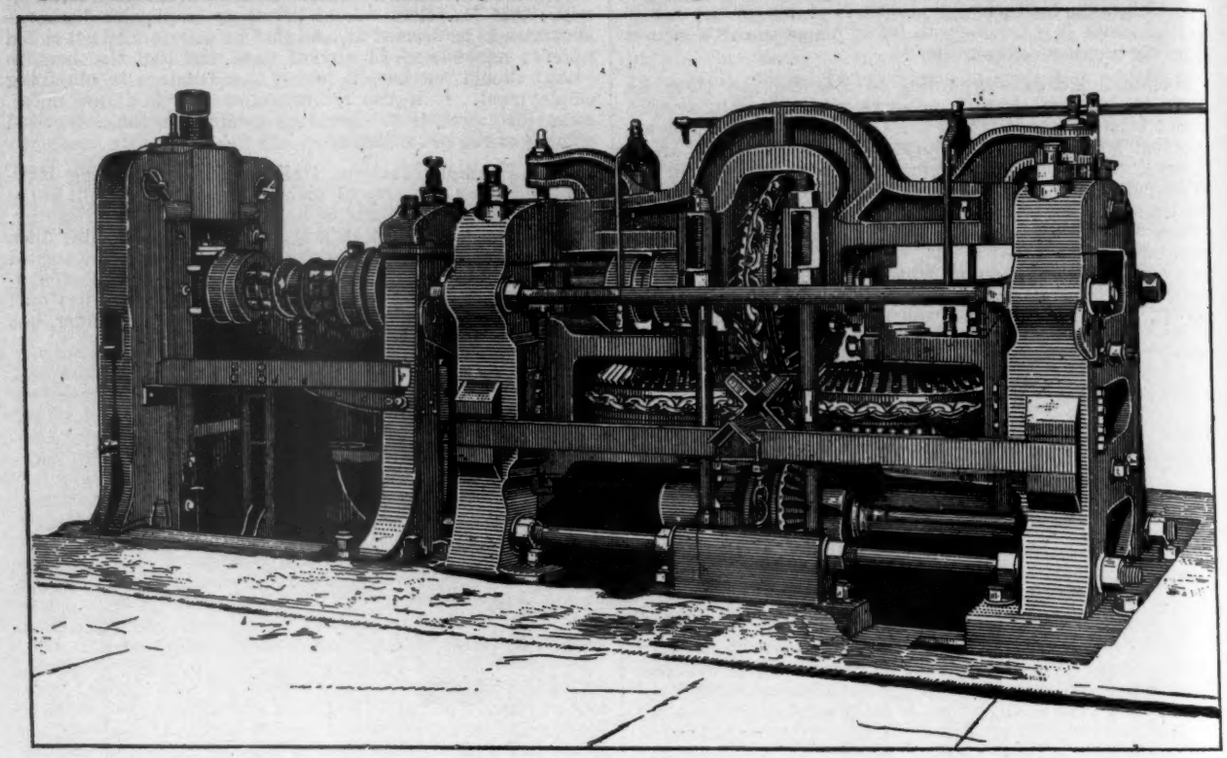


Fig. 1.

MACHINE FOR ROLLING CHAINS

that goes in looking like fig. 2 comes out looking like fig. 3. By means of tongs, and cutters, and moulds fig. 3 is made to look like fig. 4, in which the links are held together by very thin bits of iron which are easily cut. After some little labor in cleaning the links, the chain is run into a furnace, heated

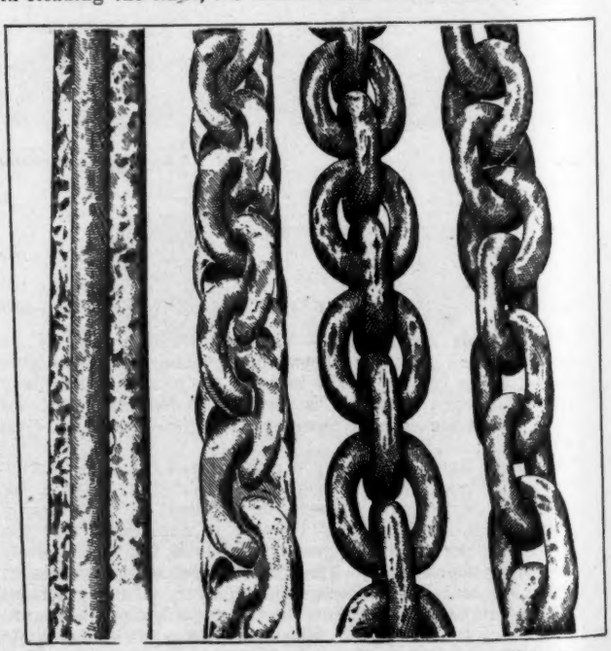


Fig. 2. Fig. 3. Fig. 4. Fig. 5.

VARIOUS STAGES OF MACHINE-ROLLED CHAINS.

red, and then run through rolls to give its links the shape seen in fig. 5. It is claimed that this machine-made chain is better than the hand welded; that it does not require wrought or welding iron, but that it gives better results with fused irons and steels."

THE DETERIORATION OF LOCOMOTIVE AND MARINE BOILERS DUE TO EXPANSION, AND THE MEANS OF LESSENING THE SAME.*

By Herr Lentz.

(*Concluded from page* 168.)

In some quarters the further introduction of the stayless boiler is regarded as dangerous, or it is advocated that the corrugated furnaces should be connected to the outer shell with stay-bolts, so that a further comparison might be made later, since we are not perfectly clear as to the cause of the deformation just mentioned.

Now, a few months before the accident, while a new furnace was being put in a boiler at Nippes, I was inspecting it and found that the corrugated portion had contracted so that the furnace was about 1.2 in. shorter on the top and .4 in. shorter on the bottom than it should have been; a fact that neither the maker of the furnace nor myself could explain, unless we attributed it to imperfect workmanship.

According to calculations which I will present to you, it is probable that the furnace was upset to the amount of these measurements, and must likewise, in accordance with other measurements, have experienced a flattening of about 4 in., though the diametrical measurements have unfortunately not been verified.

The engine was in heavy express service for three weeks in this condition, and this was enough to increase the flattening (to about 8 in.), so that it collapsed under the pressure of the steam.

In calculating on the efficiency of this boiler, I have come to the conclusion that it evaporated about 13,200 lbs. (1,500 galls.) of water per hour into steam of 180 lbs. pressure.

From the known investigations on elasticity I have calculated Table A for a depth of corrugation of 50 mm. (2 in.), and Table B for a depth of corrugation of 75 mm. (3 in.). The latter can make no claim to absolute accuracy, since furnaces with that depth of corrugation are not in demand, and I can only check them off with the results obtained with corrugations having a depth of 30 mm. ($1\frac{3}{16}$ in.) and 50 mm. (2 in.); but it is approximately correct.

* Paper read before the *Verein für Eisenbahnkunde.*

According to the Schulz-Knaudt investigations, we have the following rules for the compressibility and limit of elasticity of corrugated flues:

1. The unit of compressibility for corrugations 2 in. deep is .0041 in. per foot of length, for sheets .39 in. thick, and subjected to a pressure of 20,000 lbs. per square inch, the furnace having a diameter of 37.5 and 41.5 in.

2. The amount of compressibility varies approximately with the mean diameter of the flue, the thickness of metal remaining the same.

3. The amount of compressibility varies approximately as the square of the thickness of the metal, the diameter of the flue remaining the same.

4. The amount of the limit of elasticity per foot of length is 10 times as great for a thickness of metal of .39 in. as the unit given in 1.

5. The amount of the limit of elasticity per foot of length is independent of the diameter of the flue.

6. The amount of the limit of elasticity is approximately proportional to the thickness of the metal.

7. In corrugated flues having different depths of corrugation, the amount of compressibility with the same thicknesses of metal and the same outside diameters is proportional to the square of the average depth of the corrugations.

8. In corrugated flues with different depths of corrugations the amount of the limit of elasticity is proportional to the average depth of the corrugations.

9. Accordingly, by a comparison of three corrugated flues, wherein the outside diameter is $41\frac{1}{2}$ in. and the metal .40 in. thick, with corrugations $1\frac{3}{16}$ in., 2 in., and 3 in. deep, we find the following state of affairs to exist:

Depth of Corrugations.	Average Depth of Corrugations.	Ratios of the Average Depth of Corrugations.	Square of this Ratio.	Compressibility per ft. of Length at 20,000 lbs. Pressure.	Limit of Elasticity per ft.
1.2 in.	.80	1	1	.0010 in.	.0225
2.0 "	1.60	2	4	.0040 "	.0450
3.0 "	2.60	3.25	10.56	.0108 "	.0732

TABLE A.—ELASTICITY AND LIMIT OF ELASTICITY OF FLUES WITH CORRUGATIONS 50 M.M. (2 IN.) DEEP.

Thickness of metal	.39	.41	.43	.45	.47	.49	.51	.53	.55	.57	.59	.61	.63
Square of metal thickness	.1521	.1681	.1849	.2025	.2209	.2401	.2601	.2809	.3025	.3249	.3481	.3721	.3969
Limit of elasticity	.045	.043	.041	.039	.0375	.036	.0346	.0334	.032	.0311	.030	.029	.0281
Diameters of Flues.	Mean Diameter.												
29.5-33.5	31.5	.0052	.0047	.0043	.0039	.0036	.0033	.0031	.0028	.0026	.0025	.0023	.0022	.0020
31.5-35.5	33.5	.0049	.0044	.0040	.0037	.0034	.0031	.0029	.0027	.0025	.0023	.0022	.0020	.0019
33.5-37.5	35.5	.0046	.0042	.0038	.0035	.0032	.0029	.0027	.0025	.0023	.0022	.0020	.0019	.0018
35.5-39.5	37.5	.0043	.0039	.0036	.0033	.0030	.0028	.0026	.0024	.0022	.0021	.0019	.0018	.0017
37.5-41.5	39.5	.0041	.0037	.0034	.0031	.0029	.0026	.0024	.0023	.0021	.0020	.0018	.0017	.0016
39.5-43.5	41.5	.0039	.0036	.0032	.0030	.0027	.0025	.0023	.0021	.0020	.0019	.0017	.0016	.0015
41.0-45.0	43.0	.0038	.0034	.0031	.0028	.0026	.0024	.0022	.0021	.0019	.0018	.0017	.0016	.0015
43.0-47.0	45.0	.0036	.0032	.0030	.0027	.0025	.0023	.0021	.0020	.0018	.0017	.0016	.0015	.0014
45.0-49.0	47.0	.0034	.0031	.0028	.0026	.0024	.0022	.0020	.0019	.0018	.0016	.0015	.0014	.0013
47.0-51.0	49.0	.0033	.0030	.0027	.0025	.0023	.0021	.0019	.0018	.0017	.0016	.0015	.0014	.0013
49.0-53.0	51.0	.0032	.0029	.0026	.0024	.0022	.0020	.0019	.0017	.0016	.0015	.0014	.0013	.0012
51.0-55.0	53.0	.0031	.0028	.0025	.0023	.0021	.0020	.0018	.0017	.0016	.0015	.0014	.0013	.0012
53.0-57.0	55.0	.0029	.0027	.0024	.0022	.0020	.0019	.0017	.0016	.0015	.0014	.0013	.0012	.0012
55.0-59.0	57.0	.0028	.0026	.0024	.0021	.0020	.0018	.0017	.0016	.0015	.0014	.0013	.0012	.0011

TABLE B.—ELASTICITY AND LIMIT OF ELASTICITY OF FLUES WITH CORRUGATIONS 75 M.M. (3 IN.) DEEP.

Thickness of metal	.39	.41	.43	.45	.47	.49	.51	.53	.55	.57	.59	.61	.63
Square of metal thickness	.1521	.1681	.1849	.2025	.2209	.2401	.2601	.2809	.3025	.3249	.3481	.3721	.3969
Limit of elasticity	.0732	.0697	.0665	.0634	.0610	.0586	.0516	.0542	.0523	.0505	.0488	.0472	.0457
Diameters of Flues.	Mean Diameter.												
27.5-33.5	30.5	.0137	.0124	.0113	.0104	.0095	.0087	.0081	.0075	.0070	.0065	.0060	.0057	.0053
29.5-35.5	32.5	.0129	.0117	.0107	.0097	.0089	.0082	.0076	.0070	.0066	.0060	.0057	.0053	.0051
31.5-37.5	34.5	.0122	.0110	.0101	.0092	.0085	.0078	.0072	.0066	.0063	.0057	.0054	.0051	.0048
33.5-39.5	37.5	.0115	.0105	.0095	.0088	.0080	.0074	.0067	.0063	.0058	.0054	.0052	.0048	.0045
35.5-41.5	38.5	.0109	.0098	.0090	.0083	.0076	.0070	.0064	.0060	.0056	.0052	.0048	.0045	.0043
37.5-43.5	40.5	.0103	.0094	.0085	.0078	.0072	.0066	.0061	.0057	.0053	.0049	.0046	.0043	.0040
39.5-45.5	42.5	.0099	.0089	.0082	.0075	.0069	.0063	.0059	.0054	.0051	.0047	.0044	.0041	.0039
41 0-47.0	44.0	.0095	.0086	.0078	.0072	.0066	.0061	.0056	.0052	.0048	.0045	.0042	.0039	.0037
43.0-49 0	46.0	.0090	.0081	.0075	.0068	.0063	.0058	.0053	.0050	.0046	.0043	.0040	.0037	.0035
45.0-51.0	48.0	.0086	.0078	.0072	.0065	.0060	.0055	.0051	.0047	.0044	.0041	.0038	.0036	.0034
47.0-53.0	50.0	.0083	.0076	.0069	.0063	.0058	.0053	.0049	.0045	.0042	.0040	.0037	.0035	.0032
49.0-55.0	52.0	.0080	.0073	.0066	.0061	.0056	.0051	.0048	.0044	.0041	.0038	.0035	.0033	.0031
51.0-57.0	54.0	.0078	.0071	.0064	.0059	.0054	.0050	.0046	.0043	.0040	.0037	.0034	.0032	.0030
53.0-59.0	55.0	.0075	.0067	.0062	.0056	.0051	.0045	.0044	.0041	.0038	.0035	.0033	.0031	.0029

In these tables the thickness of the metal is given in the top line; in the second there is the square of the thickness of the metal; and in the third the limit of elasticity, which means the fraction of an inch which a corrugated flue 1 ft. in length must be compressed in order to reach its limit of elasticity. This is the same for different diameters of flues, but varies greatly with the increasing thickness of metal. In the columns beneath these there is given the compression which the various sizes of corrugated flues would experience per foot of length under a load of 20,000 lbs.

From this it will readily be seen how the corrugated flue stiffens as the thickness of the metal is increased, and how the elasticity is increased by making the corrugations 3 in. deep. Its limit of elasticity is about twice, and its actual elasticity is fully three times as great as in the case of flues with corrugations 2 in. high. An accurate calculation shows that the corrugated flue on the express engine of the Left-Bank-of-the-Rhine Railway was compressed about .37 in. at the top and about .23 in. at the bottom in the direction of its length, whereby the limit of elasticity was exceeded by about .20 in. at the top and about .06 in. at the bottom, as is fully set forth and explained in the following Table C.

TABLE C.

EQUALIZED COMPARISON OF CORRUGATED FLUE BOILERS IN WORKING ORDER.

No.	Description of Parts of Locomotive.	State Railways.			
		Left Bank-of-the-Rhine.			Hanover.
		Express Locomotive.			
		With Ordinary Corrugated Flues.	With Elastic Tube Sheets.	With Deep Corrugations.	With Copper Fire-box.
1	Depth of corrugations.....in.	2	2	3	.....
2	Steam pressure..lbs. per sq. in.	210	210	210	180
3	Outside diameter of flues....in	47.4	45.3	45.3	.....
4	Thickness of metal.....in.	.60	.55	.47	.....
5	Fibre stress.....lbs. per sq in.	7,950	7,050	9,500	.....
6	Unit of fibre stress, lbs. per sq. in.....	6,800	6,970	6,800	.....
7	Number of corrugations.....	19	14	21	.....
8	Length of corrugated portion, in	113.00	83.23	124.80	.....
9	Mean length of flue or fire-box, in.....	132.00	116.15	126.00	84.37
10	Length of tubes..... in.	118 11	143.70	124.00	153.55
11	Number of tubes.....	241	194	241	219
12	Inside and outside diameter of tubes.....in.	1.65—1.46	2—1.77	1.81—1.61	1 81—1.61
13	Sectional area of tube metal, sq. in	140.82	102.18	129.15	.....
14	Heating surface of fire-box, sq. ft.....	118.4	98.0	133.5	96.9
15	Heating surface of fire-box in per cent. of total H. P	11.9	8.2	11.27	7.5
16	Heating surface of tubes, sq. ft	874.6	1077.5	1051.1	1184 0
17	" " total ...sq. ft.	993.0	1175.5	1184.6	1280.9
18	Grate area..... .....sq. ft.	21.5	19 4	19.4	24.8
19	Length of grate, including fire-brick ....in.	88.6	60.4	86.6	88.6
20	Length of combustion chamber, in.....	43.3	36.2	39.4	.....
21	Maximum coal consumption per hour per sq. ft. of grate area, lbs.....	109.6	109.6	121.9	.....
22	Maximum coal consumption per hour for the whole grate, lbs.	1,650	1,650	1,650	2,046
23	Maximum evaporation, lbs.....	13,200	13,200	13,200	15,400
24	" " fire-box, per cent. of whole.....	41	34	40	32
25	Maximum evaporation, tubes, per cent. of whole.....	59	66	60	68
26	Maximum evaporation, fire-box, lbs.....	5,412	4,488	5,280	5,082
27	Maximum evaporation, tubes, lbs.....	7,788	8,712	7,920	10,318
28	Maximum evaporation, fire-box, per sq. ft.....lbs.	45.5	45.5	39.4	52.3
29	Maximum evaporation, tubes, per sq. ft.....lbs.	8 8	8.2	7.7	8.5
30	Temperature of steam, Fahr....	387	387	387	374
31	Mean temperature of fire-box, Fahr	752	752	698	793
32	Mean temperature of tubes, Fahr	537	536	534	523
33	Mean temperature of outer shell Fahr.....	369	369	369	357
34	Average difference of temperature between corrugated flue and shell..... .....Fahr.	383	383	328	436
35	Average difference in temperature between tubes and shell Fahr	168	167	165	166
36	Relative expan-ion of fire-box, in.....	.33	.29	.27	.24
37	Relative expansion of tubes, in.	.13	.16	.13	.17
38	" " below grates, in.....	.03	.02	.03	.....
39	Relative expansion of stay-bolts in.....	.....	.....	.....	.003
40	Relative expansion below combustion chamber	.11	.09	.08	.....
41	Total relative expansion of corrugated flue and tubes at the top.....	.46	.45	.40	.41
42	Total relative expansion of corrugated flue and tubes at the bottom...	.27	.28	.24	.52
43	Smallest diameter of boiler, in.	65	65	65	55
44	Thickness of metal .. .. in.	.67	.67	.67	.55
45	Sectional area of metal..sq. in.	136.6	136.6	136.6	95.4
46	Longitudinal strain on boiler from steam pressure . .lbs.	658,577	658,577	658,577	406,395
47	Longitudinal strain per sq. in. of metal.....lbs.	4,821	4,821	4,821	4,260
48	Extension of boiler resulting from longitudinal strain...in	.043	.043	.043	.036
49	Excess of compression of fire-box at top..... .....in.	.417	.407	.357	.374
50	Excess of compression of fire-box at bottom... ..... in.	.227	.237	.197	.....
51	Compression of corrugated flues per ft. of length at 20,000 lbs., in.....	.0019	.0023	.0075	.....
52	Total compression of the whole flue..... ....in.	.0163	.0159	.0780	.....
53	Expansive pressure of the corrugated flues upon the tubes, lbs.....	511,656	511,949	91,538	.....
54	Steam pressure upon the tube-sheet, deducting the tube areas . ... lbs.	240,548	202,694	196,720	.....
55	Resultant pressure on tubes, lbs	271,108	309,255	.....	.....
56	" " " " per sq. in. of metal . .....lbs.	1,925	3,026	.....	.....
57	Resultant pull on tubes....lbs.	.....	.....	105,182	.....
58	" " " " per sq. in. of metal .. ..lbs.	....	.....	815	.....
59	Resultant shortening of tubes, in....	.008	.015	.....	.....
60	Resultant lengthening of tubes, in..	....	....	.0085	.. . .
61	Excess of compression of fire-box at top.....	.409	.392	.3600	.....
62	Excess of compression of fire-box at bottom.....	.227	.237	.197	.....
63	Limit of elasticity of corrugated flues per ft. of length.... in.	.030	.032	.061	.....
64	Limit of elasticity of the whole flue..... ....in.	.2825	.2219	.6344	....
65	Limit of elasticity reduced to ½ in...	.1719	.1350	.3605	....
66	Limit of elasticity exceeded at the top..... .....in.	.2371	.157	.....	.....
67	Limit of elasticity exceeded at the bottom..... ... .in.	.0551	.1020	.....	....
68	Compression falling short of limit of elasticity at the top, in.....	....	.....	.0005	....
69	Compression falling short of limit of elasticity at the bottom..... .....in.	.....	.....	.1635	.....
70	Minimum necessary expansion for flexible sheet... .....in.	.20	.24	....	.40
71	Maximum necessary expansion for flexible sheet..... .....in.	.37	.38	.. ..	.60

No. 6 shows the actual demands that are made upon the metal.

Nos. 7 and 8 are given as they determine the elasticity and limit of elasticity.

No. 15 serves for the calculation of Nos. 24 and 25.

Nos. 21 and 23 and 26 and 27 give the maximum coal consumption and the steam production that obtains in actual service.

Nos. 24 and 25 are calculated on the authority of Couche.

No. 31. The mean temperature of the corrugated flues is taken from Hirsch's experiments, and, indeed, in order to determine the temperature of sheets covered with a scale .12 in. thick, the angle formed by the lines II and IV for .04 in. and .20 in. of scale respectively is bisected by the dotted line, and then the line II is lengthened out below, so that with the dot and dash prolongations it becomes the basis of the calculations (fig. 2, page 134); but as Hirsch's figures were obtained by experiments on open boilers and at a temperature of 212° F., about 180° F. has been added to these figures, as

found to correspond to the higher temperature of the steam. In the same way as for 31 the mean temperature of the corrugated flues was found, while for a steam generation of 56.6 lbs. per square foot (see 28) we obtain a temperature of 450° F., and as the steam temperature (see 30) is 387°, subtracting 180 leaves 207° to be added, which gives 450° + 207° = 657° F.

No. 32 is found in the same way as Nos. 29 and 30.

No. 33, the mean temperature of the outer shell, is the same as the steam temperature given in No. 30, less about 5 per cent.

No. 36, the relative expansion of the corrugated flue, is calculated from No. 34, the difference in temperature between the flue and the outer shell, the length of the flue as given in No. 9, and the coefficient $\frac{1}{1530}$, which is that for the expansion of wrought iron per 100° F. As an example for 36, we have $\frac{383 \times 132}{100 \times 1530} = .33$ in. for the first column.

No. 37 is calculated in the same way from Nos. 10 and 35, and is $\frac{168 \times 118\ 11}{100 \times 1530} = .13$ in. for the first column.

No. 38. The temperature of that portion of the corrugated flue lying beneath the grates is estimated to be about 54° F. higher than that of the outer shell, we therefore obtain 38 from No. 19 and find it to be $\frac{54 \times 88.6}{100 \times 1530} = .03$ in. for the first column.

No. 40. The temperature of the corrugated flue in the combustion chamber is taken to be the same, both at the top and at the bottom. No. 40 is therefore calculated from Nos. 20 and 34 as follows: $\frac{383 \times 43\ 3}{100 \times 1530} = .107$ in. for the first column.

No. 41 is found from Nos. 36 and 37, and is thus obtained for the first column .33 + .13 = .46 in.

No. 42 is derived from Nos. 37, 38, and 40 as follows for the first column.

No. 48. The expansion of the outer shell from the steam pressure acting longitudinally is calculated from the fibre stress, No 47 from the modulus of elasticity of 28,380,000 lbs. per square inch, and the total boiler lengths as taken from Nos. 9 and 10. For the first column of No. 48 the equation is $\frac{4821 \times 250.11}{28{,}380{,}000} = .0425$.

No. 49. The excess of compression at the top of the corrugated flue is equal to No. 41 minus No. 48. For the first column the equation is .46 − .043 = .417 in.

No. 50 is equal to No. 42 minus No. 48. For the first column the equation is .27 − .043 = .227 in.

No. 51 is taken from Table A with corrugated flues having corrugations 2 in. deep.

No. 52 is No. 51 times No. 8 (divided by 12) in inches.

No. 53. The expanding pressure of the corrugated flue upon the tubes is equal to the expansion of the flue at the top. No. 49 divided by No. 52 and multiplied by 20,000. For the first column the equation is $\frac{.417 \times 20{,}000}{.0163} = 511{,}656$ lbs.

No. 54 is calculated from the external diameter No. 3, from the external diameter of the tubes No. 12, the number of tubes No. 11, and the steam pressure No. 2.

No. 55 is equal to No. 53 minus No. 54, when No. 53 is greater than No. 54.

No. 56 is calculated from Nos. 11, 12, 13, and 55.

Nos. 57 and 58 result from the fact that No. 54 is greater than No. 53, and is calculated in the same way as Nos. 55 and 56.

No. 59. The shortening is estimated from the fibre stress No. 56, from the modulus of elasticity of 28,380,000, and the length of tubes No. 10. For the first column the equation becomes: $\frac{1925 \times 118.11}{28{,}380{,}000} = .008$ in.

No. 60. The lengthening of the tubes is calculated in the same way as No. 59.

No. 61 is equal to No. 49 minus No. 59, or plus No. 60 in case No. 59 is zero.

No. 62 is equal to No. 50, since the compression for the lower half of the corrugated flue is so much less than for the upper, and as this lower pressure is met by the steam pressure on the tube-sheet, and it thus comes about that no special pressure is brought against the tubes.

No. 63 is obtained from Table A for the corrugations 2 in. deep, and from Table B for the corrugations 3 in. deep.

No. 64 is No. 63 multiplied by the length of the corrugations No. 8 in inches, and divided by 12.

No. 65. According to fig. 3 we have placed the limit of elasticity of wrought iron at 60° F. at about 14,835 lbs. per square inch of section, while at between 550° F. and 700° F. it is only about 9,000 lbs. Now, since the corrugated flues in service are working at a temperature of from 550° to 700° F., and as Tables A and B are only calculated for 60° F., it is evident that a limit of elasticity must be adopted for these flues that corresponds to these high temperatures, since these alone are met with in service. Then, since 14,835 : 9,000 = 23 : 14, we find the true limit of elasticity corresponding to No. 65 by multiplying No. 64 by $\frac{14}{23}$, which, in the case of the first column, becomes $\frac{.2825 \times 14}{23} = .1719$ in.

Nos. 66 and 68 are obtained from No. 61 minus No. 65, and will, therefore, be positive or negative according to the value of No. 66 relatively to No. 68.

Nos. 67 and 69 are obtained in the same way from No. 62 minus No. 65.

No. 70 is the minimum possible expansion allowable with the use of a flexible tube-sheet.

No. 71 is the maximum possible expansion allowable with the use of a flexible tube-sheet.

Now my proposition would be that instead of attaching the corrugated flue to a stiff ring we fasten it to an elastic one at the back end, as shown in fig. 16, page 168, which, according to my observations, should have a thickness of $\frac{1}{4}$ in , a breadth of $7\frac{1}{2}$ in., and a spring of about .4 in. without reaching the limit of elasticity, so that the tubes should be left perfectly free to expand and the corrugated flue itself be subjected to only a very slight compression.

It does not seem desirable to contract the back diameter of the corrugated flue, though it may involve increasing the diameter of the back end of the boiler if it is not done. It is only during a cold-water test that a pull will be exerted by the tubes, while they will be free to expand when in service, and the loosening of the tubes, which has been an objection to the stayless boiler, will no longer occur. At the present time there are 32 boilers built on my system in service in Germany; there are a number in use in other countries; some have recently been put out of service on the Prussian State railways on account of some inexplicable deformations, but I hope that as soon as I have put flexible rings in them they will be restored to service.

The question of longitudinal elasticity is a burning one for the whole range of technical boiler work, not only upon locomotives, but also in vessels and for stationary service. It is, therefore, not right to escape further trials by merely putting certain locomotives out of service, but rather carry the experimental work on so as to prove in the shortest possible time whether the flexible base ring will counteract this tendency to deform. In my opinion this is the case, and I can only urge that these investigations be continued.

On the other hand, an attempt is made to explain that the flattening of the corrugated flue is caused by its assuming an oval shape due to the unequal heating, and this has been observed to be the case in marine and stationary boilers. While this may be perfectly correct, we see the results, but not the reason.

In order to make the foregoing clear, let us take a lead pipe fastened at one end, and then having its upper half, corresponding to the excess of expansion of the corrugated flue, compressed longitudinally, it will then be under the same working stress as though we bent it upward, and it will then flatten on the top and show the same cross-section as the flattened corrugated flue.

If the corrugated flue is maintained at the same temperature all of the way around, even though the limit of elasticity may be passed and it may be upset, it will still retain the same circular form of cross-section as in the combustion chamber. In point of fact it is only above the grate that there is this one-sided compression and flattening, while the cooler portion remains nearly in its circular form.

Gentlemen, it is not my intention to handle exhaustively the details which I have investigated, as there is no time for that. Neither have I any intention of claiming a construction that has been absolutely perfected in the light of the defects that have been developed, but to assert that the design using a flexible head for express locomotives in conjunction with self-adjusting stay-bolts is a very great improvement; I merely point it out as best may be and still remain on the outlook for further improvements.

In this paper I have attempted to show how defective our methods of boiler construction are, how necessary it is that they should be improved, and how it seems to me that this

end can be attained. On the other hand, I have desired to place my system of boiler construction, to which I have devoted a great deal of attention during the past five years, in a proper light before you, especially since the reason for the explosion at Bonn remained unexplained for a long time and was first cleared away by my efforts.

Had this boiler been fitted with flues having deeper corrugations with a depth of 3 in. instead of 2 in., or with a flexible back ring, as shown in fig. 16, page 168, so that the flue would not have been upset, it would not have been flattened nor collapsed, and the stayless boiler, which is considered to be the boiler of the future by many men in charge of railroad locomotive departments, would not have had the ban put upon it as now seems to be the case.

With this flexible ring the stayless boiler is perfectly free to expand internally, and this ring takes on the minimum flexure so readily, and the limit of elasticity is so far from being reached, that there is no possibility of a resultant danger. Furthermore, the construction of the boiler is as simple as it can well be conceived that a boiler can be, so that it is very much to be deplored that this type of boiler should have had such a set-back.

I hope that I have succeeded in convincing you of the accuracy of my reasoning, and of awakening an interest in the improvement in our boiler construction, and that by means of these improvements both our marine and locomotive boilers will be constructed in the future with a better regard to free expansion.

DISCUSSION.

Herr Bork: As it would occupy too much time to enter into a discussion of individual or comprehensive applications, I will confine myself principally to a brief exposition of the further adaptation of corrugated flue fire-boxes to locomotive boilers.

In regard to the testing of such an arrangement of boiler stay-bolts as will permit them to have a slight motion corresponding with the changes of temperature, it must not be allowed to pass unnoticed that such or similar constructions have been very frequently made, but that they have not, as yet, received a general application, because their use is often troublesome and expensive, and because of the difficulty of designing those that are suitable.

Again, as to the interpolation of a flexible ring between the tube-sheet and the shell of the boiler, it is, in my judgment, a faulty method of procedure, because there is neither any absolute necessity for it nor can any great advantages be expected from its use. Furthermore, if in the construction of a boiler the greatest possible care must be taken that changes of form can readily follow all changes of temperature without inducing any essential relaxation of the serviceability of the various parts of the boiler, this point must not be exclusively insisted upon, for there are many other points to be observed in securing protection against undue straining while in service and safety from explosions.

Should the proposed application of corrugated flues to locomotive boilers be carried still further, it might almost be predicted, in view of the explosion to which attention has been called, that its serviceable life would be still shorter. My opinion has already been confirmed by this explosion, which evidently did not occur through lack of water, that corrugated flue fire-boxes do not possess the necessary safety in adjustment and under varying pressures that it is necessary for those used in locomotives to possess. The author has endeavored to convey the idea that, with a somewhat different construction, the boiler will be made perfectly safe, and sets forth the opinion that, contrary to the ideas that have thus far been accepted, the corrugated flue offers a very considerable resistance to longitudinal compression. Consequently, as heating puts a longitudinal pressure upon the flue, it creates so great a bending moment that it actually does bend the flue, which in itself causes a further flattening and lessening of the cross-sectional area that finally results in a collapse. These distortions will, therefore, now be entirely obviated if, instead of fastening the corrugated flue directly at the back end, as has been done up to the present time, we make this attachment to the outer shell by means of a flexible ring, besides carrying the flue straight out to the end instead of contracting it.

If it can be conceded that with each faulty application of a contracted corrugated flue a bending moment is present, it is readily seen by closer observation that even with reference to the comparatively short arm of the lever upon which the longitudinal pressure acts, and the high moment of resistance of the cross-section of the flue, no appreciable bending and consequent flattening of the cross-section is likely to take place. It seems, furthermore, that the bending which occurs in the flue under normal working conditions is due solely to the influence of the unequal heating of those portions of the flue that lie above and below the grate, and were the ends of the flue to be perfectly free to move, it is probable that this variation of the cross-section from the truly circular form would be considerably greater. When we consider these changes of form, which cannot well be prevented in a corrugated flue, the proposed use of a flexible ring between the end of the flue and the outer shell would seem to have no influence whatever. Further, it is my unbiassed opinion that with the ordinary ring a far greater freedom of motion for the corrugated flue will result, because, in proportion to the number of corrugations, the flexibility of a ring appears to gain in safety from increasing thickness, and its capability of adjustment becomes of less importance. Again, the unequal heating of the top and bottom halves of the corrugated flue are entirely separate considerations, to which the dangerousness of such fire-boxes are traceable. The corrugated fire-boxes which are now applied to all boilers with circular fire-boxes are placed under contrary conditions to all the other circular portions of the boiler which are subjected to an internal pressure, in that they, when subjected to an equal strain on all parts, are not in a position to be forced back to their original circular form after any change in their shape has taken place.

With reference to the exceeding of the limit of elasticity, it is evident that the portion of the flue referred to will vary more and more from the circular form, while a flue subjected to an internal pressure will be forced back into the original circular form if by any chance it should vary from it.

In addition, the very great disadvantage under which a flue subjected to an external pressure labors lies in the fact that its tendency to a comparatively slight variation from the circular shape is considerably greater, since even in the original circular form there is an ever-present tendency, due to the strain on the several parts, to set up a bending moment. These supplementary strains increase in a direct ratio with the variation from a circular form, and are of such importance that, taking the measurements of the exploded boiler that has been cited as an example, we find that a steam pressure of only 160 lbs. per square inch under the conditions of only .6 in. of flattening, exerted a strain upon the summits of the corrugations that exceeded the limit of elasticity of the wrought iron. Starting at this point, under the influence of the normal steam pressure and the increasing influence of the temperature, it is possible that a marked deformation should take place which straightway led to a collapse, if a longitudinal increase in the dimensions of the flue does not take place.

The objection can be made that variations of .6 in. from the circular form can be obviated by taking greater care in the rolling and welding. On the other hand, it may be argued that absolute perfection in the formation of a circular corrugated fire-box is impossible of attainment, and variations of .6 in. in the construction are quite likely to occur. But even though the original form may have been exactly circular, it will not be long before, under the conditions of normal service, circumstances will arise under which a wide change of shape may result.

Then the changes of the circular shape are so conditioned that the inner surface of the upper half of the tube which is turned toward the fire has a somewhat higher temperature than that which is washed by the water, and will be increased by these working conditions if by means of a coating of grease or scale or any other influence the flames should produce a still higher temperature. Then it is, of course, evident, as has been already mentioned, in referring to the variations from the original sectional shape, that that portion of the flue lying above the grate has a markedly higher temperature than that which is below. This action has been detected by the corresponding inspections that were mentioned in the paper, that on measuring a number of corrugated fire-boxes, each of which had been in service but a short time, variations of 1.2 in. from the circular form were found. The great danger in the use of the corrugated fire-box may, therefore, be regarded as twofold.

It may be said that the raising of the duties of the locomotive will, in the first place, necessitate a further raising of the pressure of steam that is carried, and that this may possibly rise to 300 lbs. per square inch; from which it is very evident that no corrugated fire-box can be used, since now, with a pressure of only 160 lbs., a terrible explosion has taken place.

After taking everything into consideration, I am of the opinion that, even with the changes that have been advocated here to-day, there can be no reason for the adoption or use of a corrugated fire-box, and that railroad managers who are impressed with the difficulties of the service will be led with

great difficulty to sanction any further changes in the designs of their locomotive boilers.

Herr Lentz: I must take exception to the statement of the gentleman who has just spoken in regard to the difficulty of making corrugated flues round. On the contrary, in the manufacture of corrugated flues, as carried on in the rolling mills of Schulz & Knaudt, these flues must be round when they come out of the rolls, and cannot be made in any other condition. Then, as it is easy to make such a flue exactly circular, it is exceedingly difficult to force it out of shape; to accomplish which a pressure of from 900 to 1,200 lbs. per square inch would be required. In the same way the material has the power of resisting a high degree of heat; even at a temperature of 1,100° F. the condition of the metal leaves nothing to be desired, since the tensile strength of wrought iron will still be 21,300 lbs. per square inch of section, while copper will have dropped to zero.

As for the changes in construction which I have advocated, and to which the gentleman has taken exception, I wish it to be understood that I have in no way maintained that the designs which I have submitted must be taken as models in all of their details; I have merely had the purpose in view of developing an improvement. I do, however, hold fast to the principles that the use of self-adjusting crown-bar stays and stay-bolts are of great value, and that nothing should be sanctioned, even though the change may appear to be an improvement, which complicates the construction, but does not make it better. I also disagree with the gentleman, if he means to say that the flexible ring, which I have used to increase the freedom of motion of the corrugated flues, does not fulfil this purpose. No limit is set to the flexibility of this ring; of course one cannot make it as thin as one may choose, but every metal is adaptable to this portion of the construction, even copper itself being unhesitatingly employed, provided that the temperature at the place where the ring is set is correspondingly low.

Finally, in the case cited by the gentleman, where it may become necessary to raise the steam pressure in locomotives, which will certainly be done, the difficulties that he will meet will lie in the fact that at the higher temperatures, which are inseparably connected with higher steam pressures, the strength of copper falls away in a very marked manner, so that it becomes practically out of the question to use it, while the corrugated flue, even at these high temperatures, has a strength amply sufficient to resist the strains that are put upon it.

TRIAL OF A SCHMIDT MOTOR (BOILER SUPERHEATER AND COMPOUND ENGINE).

Engineering of a recent date gives a summary by Bryan Donkin, M.I.C.E., of a report by Professor M. Schröter, of Munich, of an experimental test of Schmidt's superheated steam boiler, which was illustrated in the last and also in the February number of THE AMERICAN ENGINEER. In this report it is said:

"On the first day's trial the steam left the superheater at a temperature of 662°. The temperature of saturated steam at that pressure equals 374°, being a difference of 288°, the extent to which the steam was superheated. It entered the engine at a temperature of 604°, showing a loss of 58° in the steam-pipe. On the second day the temperature of the steam on leaving the superheater was 674°, or 300° of superheat, and it entered the engine at a temperature of 651°, or a pipe loss of 23°. This was due to the attention paid before the second trial to having the steam-pipes carefully covered. Too much stress cannot be laid on this point where superheated steam is used. A far greater economy than is usually thought possible may be obtained, even with saturated steam, by isolating the pipes, but with superheating, even with pipes of ordinary length, the whole advantage may be lost if the pipes are not carefully protected. The initial temperature of the steam in the high-pressure cylinder has a great effect upon the economy. The diminished consumption of feed-water in the second experiment—viz., 6 per cent.—as compared with the first, is ascribed by Professor Schröter to the increase in the temperature of the superheated steam from 604° to 651°. The hot gases in the flue fell below the temperature of the saturated steam. . . .

"If an analysis be made of the way in which the boiler utilizes the heat contained in the coal, it will be seen that the use of the highly superheated steam is not only of advantage in a steam-engine, but that it can be generated without a large expenditure of heat. The temperature of the feed-water is first raised by the heat of the gases about 108°; it is then converted into saturated steam, and the latter raised and superheated at constant pressure to a temperature of 651°. The amount of heat required per pound of coal to produce this result can be calculated with the usual formulæ, if the quantity of feed-water is known. The following table of the heat distribution in percentages shows that in the Schmidt motor as much care is bestowed upon generating the heat in the boiler as upon utilizing it in the engine.

		Per Cent.
Heat, July 30.	To evaporate the water into steam	63.7
	To superheat the steam	8.2
	To heat the feed-water	6.6
	Total efficiency	78.5

"The chief reason for the economical consumption of steam in this compound Schmidt engine is that all initial condensation in the high-pressure cylinder is avoided. By the peculiar arrangement of the cylinders the walls are surrounded continually with the steam of the receiver, with which the high-pressure cylinder is partially jacketed. Thus an exchange of heat is maintained between them and the working steam in this cylinder. The author, however, considers it possible that still greater economy might be obtained by some other method of construction, for according to the results here given a considerable exchange of heat also takes place in the low-pressure cylinder, in which external radiation may play a large part. Much, he thinks, still remains to be done with regard to isolating the cylinders by surrounding them with non-conducting materials. . . .

"Careful inquiry has shown that with similar engines after running some years no difficulty has been experienced with the pistons or valves due to working with highly superheated steam. This agrees with the results of experience in France."

SOME FACTS RELATING TO CERTAIN TYPES OF WATER-TUBE BOILERS.*

(*Continued from page* 164.)

UNIT NO. 4.

TUBES CLOSED AT BOTH ENDS.

THERE are only two ways by which boilers can be kept efficient and economical. The first is to feed them with absolutely pure water—practically a physical impossibility. The second is to arrange them so that the scale due to evaporation can be removed—that is, provide means which will give free access

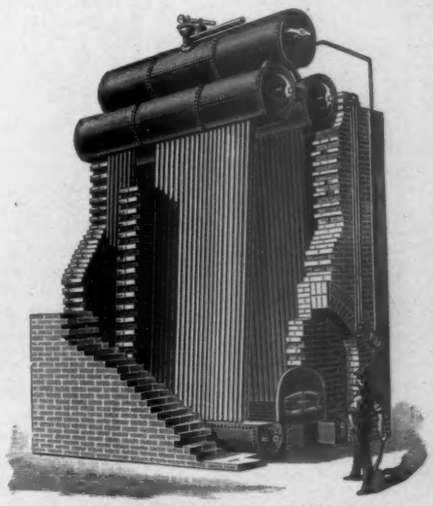


FIG. 35.—FIRMENICH BOILER, 1875.

From a Trade Circular Issued at Chicago.

to the tubes for cleaning every square inch of their internal surface. Unit No. 4 starts out all right with straight tubes, but ignores the essential point—facility of cleaning.

The Firmenich boiler (fig. 35) consisted of flat-sided horizontal drums at top and bottom of a bank of straight tubes.

* From advance sheets of a publication by the Babcock & Wilcox Company.

Two such units were placed "A" fashion, with the grates between them at the bottom, and surmounted with a steam drum on top. These tubes were inaccessible for cleaning.

If the drums were made round and the ends of the tubes

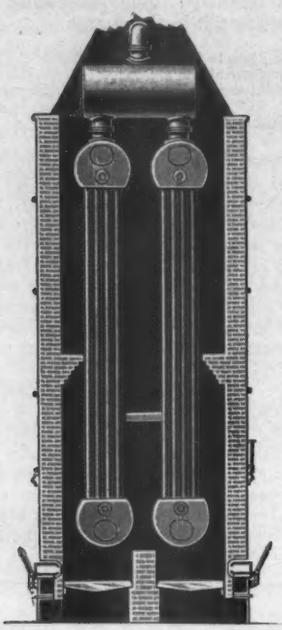


FIG. 36.—WHEELER BOILER, 1892.
From a Newspaper Clipping.

bent the units would strongly suggest several more modern boilers previously described (Stirling, Pierpont, etc.).

If the Firmenich units were placed vertical instead of at an angle, we have the **Wheeler** boiler (fig. 36), which came to us as brand new about the time the last of the Firmenichs was heard from.

The **Yarrow** boiler (fig. 37), is a slightly modified Firmenich (1875), in some instances made with small diameter drums

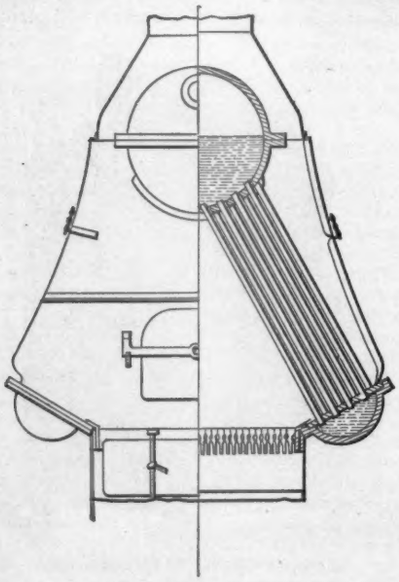


FIG. 37.—YARROW BOILER.
From Notes of Naval Progress, U. S. Navy, 1894.

bolted together in the centre, in larger sizes with the upper drums of sufficient diameter to draw the tubes into. As in all this class, the drums are greatly weakened by the large number and close proximity of the tube holes, and the sheet is liable to be strained or ruptured by expanding the tubes. When a tube leaks it is difficult to locate it, and hidden leaks are liable to cut out the metal. In the smaller sizes the tubes are accessible for cleaning by taking the boiler apart or by working in the dark and trusting to luck in the larger ones.

Babcock & Wilcox built a sectional boiler (fig. 38) with straight vertical headers. The tubes were brightened, laid in

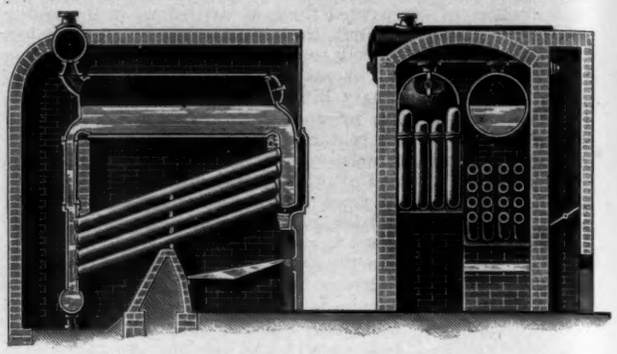


FIG. 38.—BABCOCK & WILCOX BOILER, 1868.
From the Original Drawings.

the mould, and the headers cast on. No hand-holes opposite the tubes were provided. It died very young.

Maynard (fig. 39) used a horizontal steam and water cylinder above a bank of tubes placed at a slight inclination from the horizontal; the ends of the tubes were expanded into

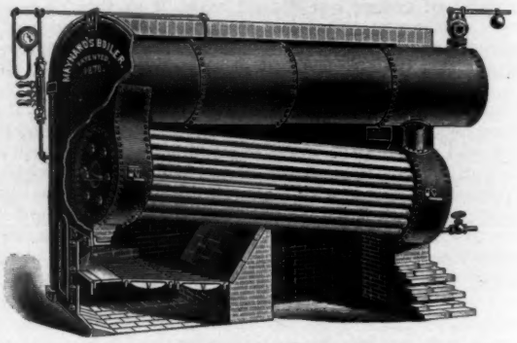


FIG. 39.—MAYNARD'S BOILER, 1870.
From a Trade Circular.

round boxes having stayed heads connected to a horizontal drum. The course of the gases was back and forth lengthwise of the tubes—in fact, a Heine boiler of earlier date without any hand-hole openings opposite the tubes.

If Maynard's top drum was cut off and one large tube was

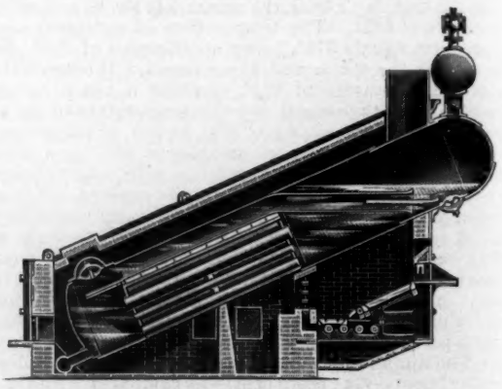


FIG. 40.—MEISSNER'S BOILER, 1882.
From a Trade Circular Issued at Philadelphia.

placed at the top of the bank for a return circulation and the front water-box was lengthened, we have **Meissner's** boiler (fig. 40).

Thompson (fig. 41) took one of Firmenich's sections, placed it in an inclined position, *à la* Maynard, beneath a return tubular boiler, and connected them at front and rear by a supply and delivery pipe.

If a round neck were substituted for the flanged neck at the

front of Maynard's design, we would have the **Wood** boiler (fig. 42).

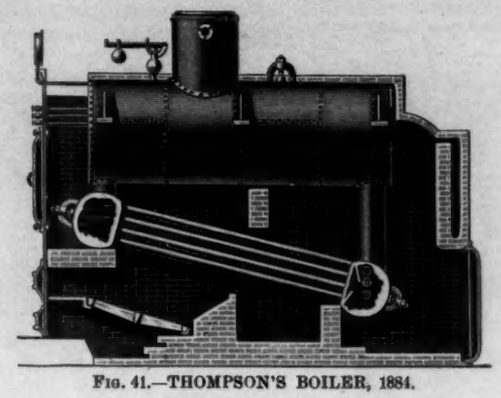


FIG. 41.—THOMPSON'S BOILER, 1884.
From a Trade Circular.

By putting Meissner's return pipe outside and rechristening it we have **Black's** boiler (fig. 43).

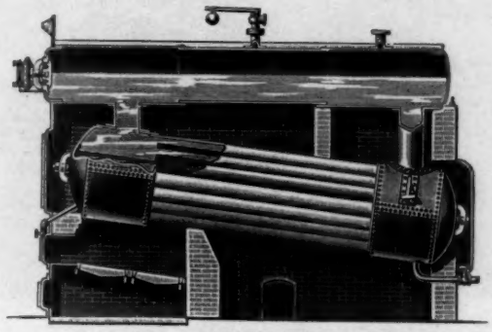


FIG. 42.—WOOD'S BOILER, 1889.
From a Trade Circular Issued at Conshohocken, Pa.

Stand Meissner's boiler vertically, put the return pipe in the middle instead of at the side, and we have **Cook's** boiler (fig. 44).

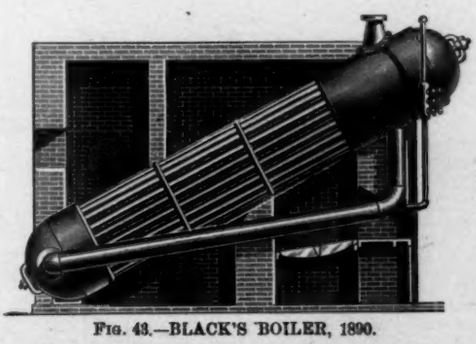


FIG. 43.—BLACK'S BOILER, 1890.
From a Trade Circular Issued at Baltimore, Md.

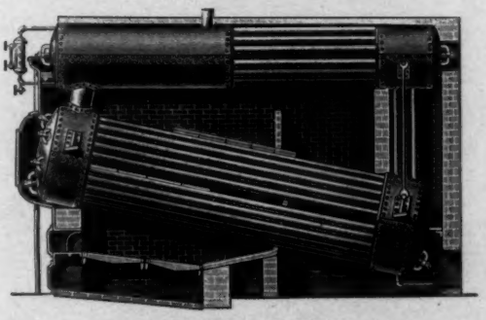


FIG. 45.—HENSHALL'S BOILER, 1892.
From a Trade Circular Issued at Tremont, Pa.

Henshall (fig. 45) took Meissner's boiler for a top drum and Cook's boiler for a lower drum, placed them in the same relative position as Maynard's two principal units, and connected them at the ends by circulation pipes.

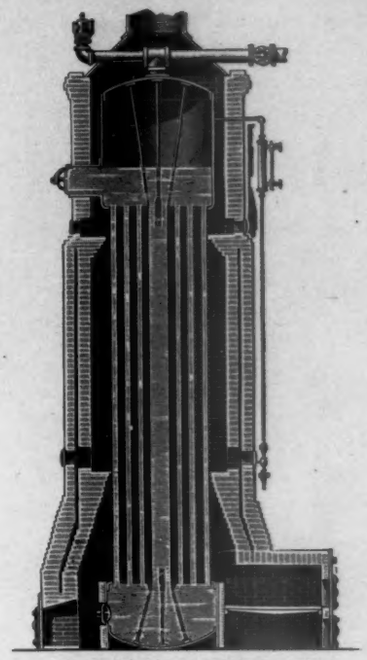
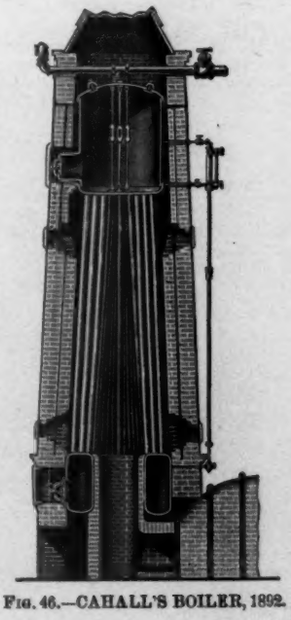


FIG. 44.—COOK'S BOILER, 1891.
From a Trade Circular Issued at Mansfield, O.

If the large central pipe is taken out of Cook's boiler and a piece is cut off and used for a flue through one of the drums,



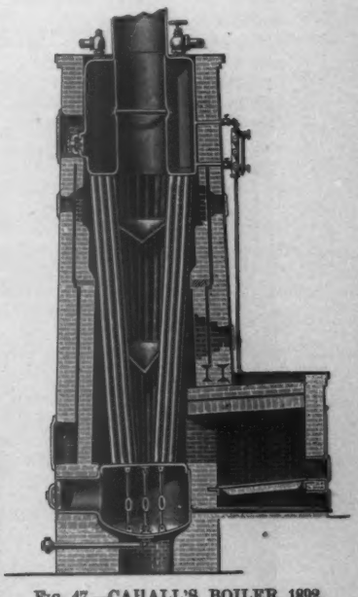


FIG. 46.—CAHALL'S BOILER, 1892. FIG. 47.—CAHALL'S BOILER, 1892.
From a Trade Circular Issued at Mansfield, O.

we have the **Cahall** double-header boiler (figs. 46 and 47), built so it can run either end up.

"He stood a spell on one foot fust,
Then stood a spell on t'other;
And on which one he felt the wust
He couldn't told ye nuther."

MORAL.

When one considers that the boilers described are only a small fraction of the different kinds offered to the public as "self-cleaning," is it any wonder that for many years the merits of patent boilers were classed with those of patent medicines and lubricating oils?

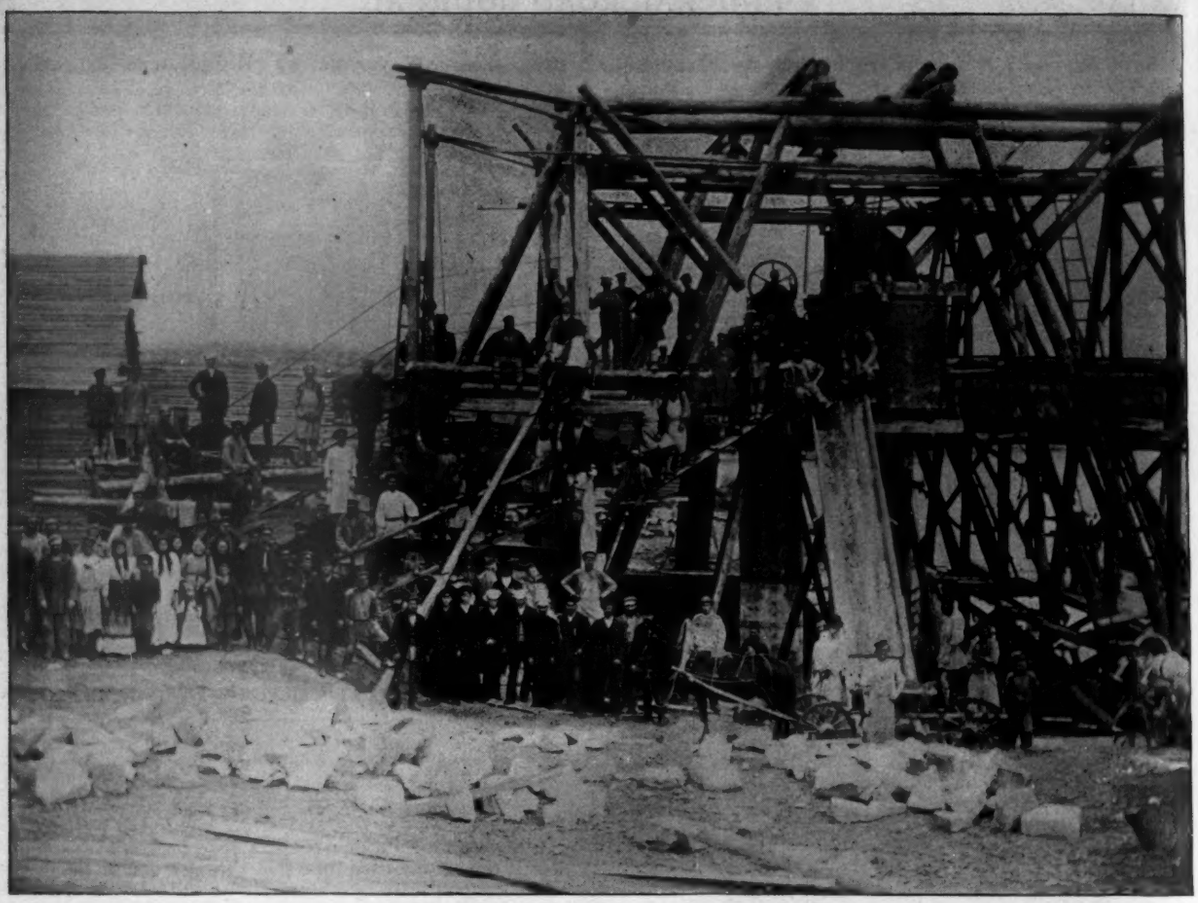


Fig. 15.—Construction of the Tobol Bridge, Sinking of Caisson, Falsework, Sluices and Transportation of Earth.

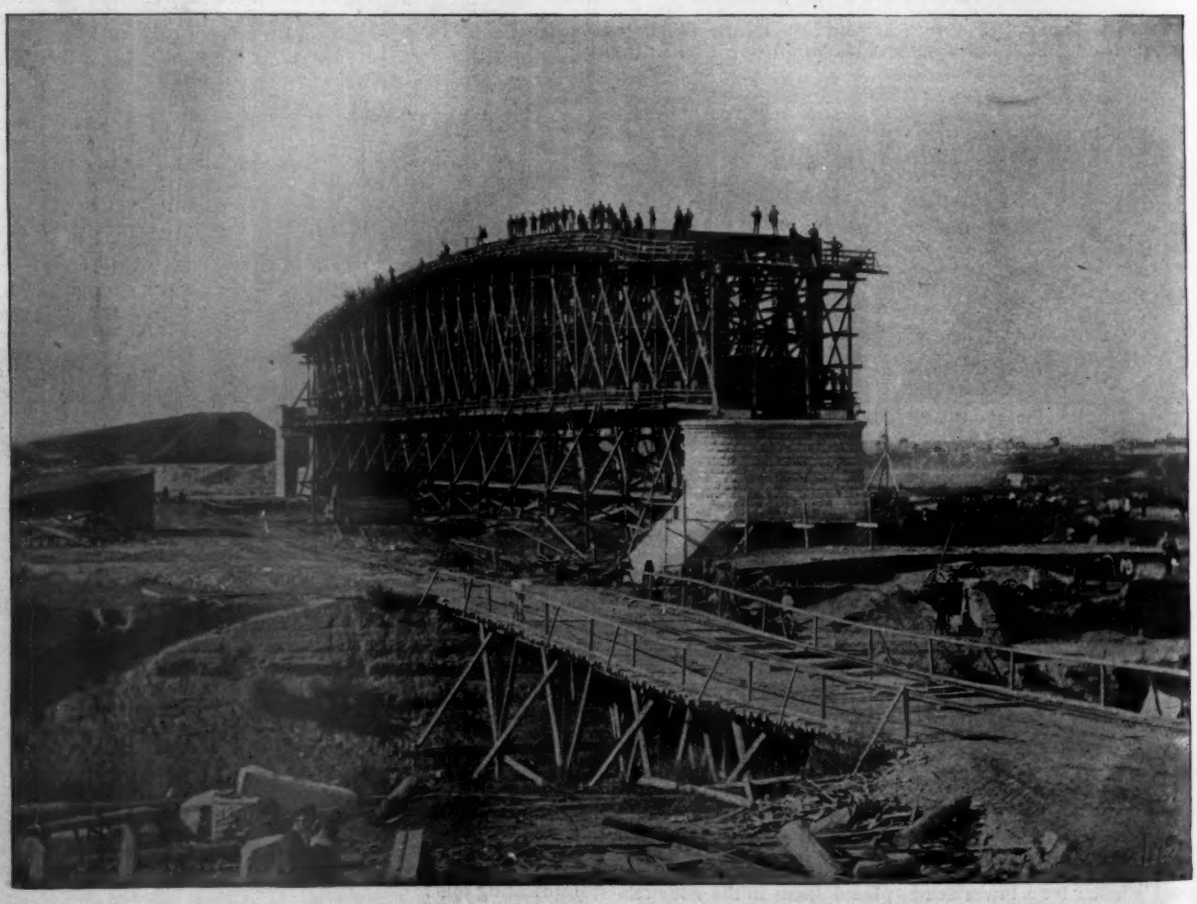


Fig. 16.—Mounting of the First Span of the Tobol Bridge in Kourhan, of which there are Three Spans of 350 ft. each.

THE TOBOL BRIDGE ON THE GREAT SIBERIAN RAILROAD.

THE GREAT SIBERIAN RAILROAD.

THE following interesting account and the two accompanying views (figs. 15 and 16), showing the progress of this great work, will interest many of our readers. The opening of this line, combined with the results of the Japanese-Chinese war, will be an epoch in the world's history the ultimate results of which no one can even imagine.

The construction of the Great Siberian Railroad has entered upon a new phase. Up to the present time it has been controlled by the Siberian Railroad Committee, presided over by the successor to the throne, Nicolas. In the twentieth session of the committee, however, which was the first after the Czarevitch Nicolas had ascended the throne, the new Emperor proclaimed that he would retain the presidency of the committee in the following language:

"Gentlemen, the institution of the construction of a continuous Siberian railroad is one of the great deeds of the glorious reign of my unforgotten father. To complete, with the help of God, this exclusively pacific and civilizing enterprise is not only my holy duty, but my hearty desire; the more so because it was intrusted to me by my dear father. I hope, with your assistance, to rapidly complete the construction of the Siberian Railroad which was commenced by him."

The vice-president of the committee, Mr. Bunge, in the name of the committee, answered in the following manner:

"We are happy that by your high will the construction of the Siberian Railroad still remains under the immediate control of your Majesty. When you were at Vladivostok your Majesty laid the first foundation of the railroad now being constructed through Siberia. After your return the late Emperor appointed you the President of the Committee of the Siberian Railroad, and by this means guaranteed the accomplishment of the task intrusted to the committee and assisted by your permanent aid. Now that your Majesty has deigned to keep in your hands the control of this great enterprise, designed to join European Russia with the Pacific coast, we are sure that the great enterprise bequeathed to your Majesty by your late father will soon be brought to the happy end, and will be the glory of the present reign as well as of the one that is past."

After this speech the Emperor proposed to the committee to deliberate on current business.

The first question of assignment of expenses for the construction of the railroad in 1895 was only mentioned, the special estimates not being as yet ready. It was suggested, however, that the estimates should be prepared with the greatest possible economy.

Then the preparatory commission for the auxiliary enterprises connected with the construction of the Siberian Railroad appropriated 351,000 roubles for the emigration of casaks (half settlers, half soldiers) from European Russia in the Amour territory, and 86,000 roubles for the transportation of 150 casaks' families belonging to the Transbaïkal militia, in the region of the Oussouri Railroad. This last measure was proposed by the Minister of War, in order to protect the Oussouri Railroad against the Chinese robbers and highwaymen.

At the close, the general data about the state of construction was considered. This data is as follows:

The first division of the Western Siberian Railroad, from Chelabinsk to Omsk, has the earthworks and small timber bridges completed. The three great bridges through Tobol, Ishim and Irtish are under construction. The first was to have been completed in March, 1895, the second in September, 1895, and the third in 1896. The track is laid on the whole division from Chelabinsk to the Irtish River (495 miles), and the telegraph line is ready. Of the "line" buildings, 60 per cent. are ready; of the station buildings, 50 per cent., and of the water-supply buildings, 66 per cent. For the provisional traffic 34 per cent. of the locomotives and 96 per cent. of the cars are supplied.

On the second division of the Western Siberian Railroad, from Omsk City to the Obi River, there is completed 72 per cent. of the earthworks, 15 per cent. of the small timber bridges, 33 per cent. of the "line" buildings, and 8 per cent of the station buildings. The track is laid on 66 miles, and 25 per cent. of the rails and 40 per cent. of "accessories" have also been supplied. Of the rolling stock, 16 per cent. of the locomotives and 56 per cent. of the cars have been delivered. Of course this condition of the work guarantees the completion of the Western Siberian Railroad in 1896 or possibly sooner.

The first division of the Central Siberian Railroad, from the Obi River to Krasnoïarsk, has only 38 per cent. of earthwork ready. Besides that, 27 per cent. of the small timber bridges, 30 per cent. of the "line" buildings, 10 per cent. of the water supply buildings, and 80 per cent. of the stone culverts are under construction. The track is laid on 200 miles, and 17 per cent. of the locomotives and 42 per cent. of the cars are supplied.

On the second division of the Central Siberian Railroad, from Krasnoïarsk to Irkoutsk, and the branch to Tomsk City, only the final location is completed, and the earthwork is begun.

The improvement of the comparatively unknown Siberian rivers Chulim and Angara has also been begun under the control of the Chief Engineer of the Central Siberian Railroad.* Chulim River for its 200 miles is cleared of stumps or "snags." On the Angara River the chief falls have been surveyed, and six steamers (four towing steamers and two ordinary scows) have been delivered.

The North Oussouri Railroad (from Grafska to Khabarovsk) and the branch Chelabinsk-Ekaterinburg are located, and the earthwork is begun.

The construction of the South Oussouri Railroad, from Vladivostok to Grafska (or Mouraviev-Amoursk), is completed (252 miles).

In all, the length of the track laid on the Siberian Railroad is now 1,012 miles, which is less than one quarter and more than one-fifth of the whole length of the Siberian main line (4,550 miles).

The twenty-first session of the Committee of the Siberian Railroad of January 4, 1895, presided over by the Emperor Nicolas, was very interesting.

In the paper presented by the Minister of War it was stated that in 1894 great topographic surveys were made. Five parties of military topographic engineers surveyed about 15,000 miles in the region of Transbaïkal Railroad, and plotted it on a scale of $\frac{1}{84000}$. Furthermore, the engineers of the Irkoutsk and Amour division have surveyed the region of the Baïkal Loop Railroad and of the Amour Railroad. All of these topographic surveys were made principally for the sake of the better location of the railroad, and therefore in connection with the surveys of railroad engineers. In addition to these, the engineers have described the climate, population, and agricultural possibilities of the country. The geographic situation of Verkne Oudinsk and Kaïdalovsk has been determined astronomically, the longitude by means of telegraph, and 29 other points by means of chronometric expeditions.

In the year 1895 the topographic surveys will be continued in five regions: 1. Along the Baïkal Loop Line and along the shore of Baïkal Sea to the harbor of Listvennichnaïa. 2. From Misovskaïa (eastern shore of Baïkal) to Pokrovskaïa (the point where the Shilka and Argoun form the Amour River); along the Transbaïkal Line. 3. From Pokrovskaïa to the Zeïa River (a tributary of the Amour). 4. From Zeïa River to the Bureïa River (also a tributary of the Amour). 5. From Boureïa eastward. The credit required for these topographic works will be 143,000 roubles (in 1895).

The Minister of Finance (Mr. S. Witte) has made a very important statement concerning the construction of the Amour Railroad. According to the last information, the first division of the Amour Railroad, from Sretensk to Zeïa River, is the most difficult. Therefore, and in order to hasten the completion of the Siberian main line, it is necessary to make the surveys and location of the second division eastward of Zeïa, from Blagoveshchensk to Khabarovsk, at once, so that, when in 1896 the earthworks on the North Oussouri Line are completed, the construction of the second division of the Amour Railroad (which is easier to construct) can be begun.

The Minister of Agriculture and State Properties (Ermoloff) presented an account on the geologic surveys of 1893 and 1894, and asked for 139,000 roubles for the same purpose in 1895. This sum was appropriated, with instructions that the geologic explorers shall chiefly search for coal which can supply the mineral fuel for the Central Siberian and Western Siberian Railroads. During the geologic surveys of 1893 and 1894 the following useful minerals were discovered: 43 mines of lignite and coal, 15 placers of gold, 36 copper ore deposits, 10 iron ore deposits, 2 lead ore deposits, 2 deposits of graphite, 1 petroleum deposit, 2 manganese ore deposits, and 1 silver ore deposit. It is most important to find mineral fuel, which can be supplied to the Western Siberian and Central Siberian Railroads, and this will be the chief aim of the geologic surveys of 1895.

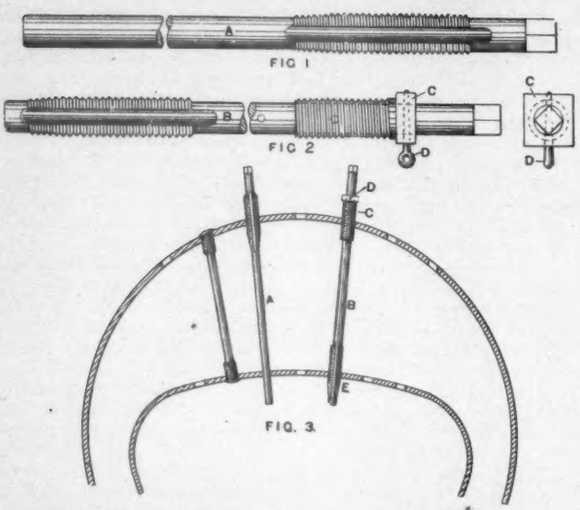
The whole length of Russian railroads is now 23,113 miles, of which 20,813 miles belong to the Government and are under the control of the Ministry of Ways of Communication, 899

* The rivers Chulim and Angara are very important for the Central Siberian Railroad, being designed as waterways for supplying the rails and other railroad materials. Chulim River, a tributary of Obi, will serve for carrying rails from the Oural Steel Works to Achinsk. Angara, connecting the Baïkal Sea with Yenisseï River, will carry rails to Irkoutsk (the eastern terminus of the railroad).

miles under the Ministry of War, and 1,401 miles to the Finland Government. During the year 1894 the State acquired the following railroads, from the great Society of Russian Railroads: The Nicolaï Railroad (St. Petersburg-Moscova), the St. Petersburg-Warsaw Railroad, and the Moscova-Nijni Railroad, in total 1,495 miles; the Riga-Dunaburg and Riga-Bolderan Railroads, 143 miles; the Mitau Railroad, 85 miles; the Rjev-Viazma Railroad, 77 miles; the Orlov-Vitebsk Railroad, 325 miles; the Dunaburg-Vitebsk Railroad, 163 miles; the Novotorjck Railroad, 85 miles, and the Lozovo-Sebastopol Railroad, 503 miles.

TAPS FOR CUTTING THREADS FOR STAY-BOLTS.

FIGS. 1 and 2 represent taps which are used in the Baltimore & Ohio Railroad shops for cutting threads for stay-bolts in the plates of locomotive fire-boxes. Their operation will be understood from fig. 3. In the latter the tap represented by fig. 1 is shown at *A*, and is used for cutting the thread in the first or outer hole. This tap, it will be seen, has an extended shank, which is inserted in the hole in the inner plate while the thread in the outer one is being cut. The direction of the tap is thus guided by the inner hole, which insures that the thread will be cut so that its axis will coincide with the centre line of the two holes.



STAY-BOLT TAPS, BALTIMORE & OHIO RAILROAD.

When the thread in the outer hole is cut the tap represented by fig. 2 and shown at *B* in fig. 3 is screwed through the outer hole, and its lower end is then inserted in the hole *E* in the inner plate. It will be seen that this tap has an extended shank on its upper end. When its lower end has been inserted in the hole at *E*, a sleeve, *C*, is slipped on the upper end. This sleeve has a screw cut on its outer surface which is screwed into the upper hole. The sleeve also has a collar on its upper end, with a transverse hole, *D*, drilled in it, which may be made to coincide with similar holes drilled in the shank of the tap. When the sleeve has been screwed into the outer hole until the hole in the collar and one of those in the shank of the tap coincide, a pin, *D*, is inserted in these holes, which holds the two so that they will turn together. Then by revolving the tap its lower threaded end will cut a thread in *E*, which will coincide with that in the outer hole. After the tap has taken hold in the inner hole, the pin *D* is removed, which will allow the tap to revolve within the sleeve.

These tools, it will be seen, save the time consumed in screwing an ordinary tap its whole length through the outer hole, and protect the thread in the outer hole from being unduly enlarged thereby.

WATER-TUBE BOILERS IN THE BRITISH NAVY.

ON a motion for going into Supply on Navy Estimates in the House of Commons recently, the subject of Water-Tube Boilers was made a subject of special consideration, and a very interesting discussion followed, which has since been succeeded by a number of letters from prominent engineers which have appeared in *The Times*. As this is a matter which is receiving special attention in this country as well as on the other side of the Atlantic, the following extracts from the discussion and from the correspondence are given, and will no doubt be of interest to many of our readers.

In discussing the measure referred to, MR. W. ALLAN, of Gateshead, said that the sole value of a man-of-war as a fighting vessel lay in the boilers, for if they failed the ship stopped. The great weakness of their Navy was due to the simple fact that there was a deficiency in the boiler power on board the vessels. The Admiralty had been trying for years to get 1 H.P. out of 1½ sq. ft. of heating surface, whereas it required 3 ft. to give such a power. By adopting this method they had rendered every ship in the Navy absolutely useless for full steam speed. The boilers were too small, and when it was endeavored to get more power out of them than they were capable of giving, the strain was too great for them to bear, and the boilers became practically useless. The three vessels, the *Blake*, the *Vulcan*, and *Blenheim*, were not four years old, and yet £120,000 was required to re-boiler the vessels. Was not that a squandering of national money? The vessels were puffed tremendously, but as soon as they went to sea the boilers completely failed. How long did the Admiralty intend to pursue this suicidal course? How long did they intend trying to get more power out of the boilers than they were capable of giving? He could only say that as long as they did so the ships of the Navy would be endangered in time of war—they would never be able to pursue an enemy or to run away from one. (Laughter.) Locomotive boilers had failed, and the Admiralty had now been driven to the adoption of water-tube boilers. But why need they have done this when even better results might have been obtained by a safer, simpler, and more economical method? His object in bringing this matter forward was the safety of our ships—the desire that our ships should be in every sense of the word first-class fighting machines. In his own experience these water-tube boilers had been tried over and over again in the mercantile marine, and they had always failed; indeed, he challenged any one to bring forward a case in which they had not failed. Yet the Admiralty had adopted them on the slight recommendation of a French engineer, who reported upon the water tube boilers in one of the vessels of the Messageries Maritimes. But did that engineer report on all the mishaps and repairs which those boilers involved, the number of spare tubes which it was necessary to carry in case of failure, and the cost they involved in the great consumption of coal? Simply upon the report of this Frenchman the Admiralty were now plunging into water-tube boilers for several of the splendid cruisers which were being built. The number of explosions which had occurred through the use of these boilers and the number of fatal accidents in connection with them were distressing. There was the case of the torpedo-boat *Sturgeon*, which was fitted with these boilers, and soon after proceeding to sea an explosion of one of the tubes occurred, killing an engineer and four men in her stokehold. These tube boilers were deemed so dangerous by a firm of shipbuilders at Barrow that the lives of engineers and stokers were insured on trial trips for £400 by the firm and provision was made in case of their disablement. Take the case of the *Hornet*. They had all heard of her performances; of how she could steam from 27 to 30 knots. Where was she now? Lying in a corner of Portsmouth Dockyard, and her boilers, only 12 months old, out of her for repair. He believed that if a return was prepared it would be found that hundreds of thousands of pounds were squandered on experiments of this kind. This was not the engineering of Great Britain—of James Watt and George Stephenson. It was the engineering of some belated and interested Frenchman. These boilers were not economical, and the aim of the Admiralty ought to be how to save coal, because the less coal they burned the fewer men would be required and the greater steaming power the vessel would possess. He could not discover the advantages of these tubular boilers. They gave less safety, less efficiency, and greater complexity. And, after all, the guns and armor of a ship were of little value if the boilers were not to be depended upon. Who was responsible for that state of things? Was it the First Lord? No; he was not an engineer. Was it the Secretary to the Admiralty? No; he was not an engineer. Was it the Civil Lord? No; he was not an engineer; he knew nothing about engines. (Laughter.) Was it the Chief Constructor of the Navy? No; he was only a shipbuilder, though a very clever one. (Hear, hear.) He wanted the Civil Lord to tell the House upon whose shoulders rested the responsibility for the water-tube boilers fitted into the torpedo-catchers and other vessels of the

Royal Navy. That was the question which he wanted an answer to. (Hear, hear.) It was a mixed-up affair, but he was determined to get at the bottom of it and to find out who was really responsible for this engineering. (Cheers.) He bade the Admiralty pause before embarking on such a huge experiment. He implored them, as an engineer, to test these boilers for themselves before fitting them into their two grandest cruisers. He would like the boilers to be first fitted into a second-class cruiser, and then have them tried at sea—not merely for a couple of hours' run, with a few newspaper correspondents on board, but running at sea till the coal was exhausted; and then, after taking in a fresh supply at some coaling station, to steam home again. Let this be done in the presence of competent experts; let the latter make a full report upon the boilers, and let that report be laid upon the table of the House. (Hear, hear.) Honorable members would then be in a position to judge. The Admiralty owed that duty not only to themselves, but to the country and to the men on board those ships. (Cheers.) If these boilers were so commendable, how came it that no shipowner in the House had adopted them? There was, he asserted, not a shipowner in Great Britain who would put into two such splendid cruisers as the *Powerful* and the *Terrible* 48 water-tube boilers apiece. Then, why should the Admiralty do it? Simply from the fact that the money was found for them to squander. (Hear, hear.) He warned the Admiralty that they would, if they persisted in their present course, be landed in endless expense, unless, indeed, some terrible disaster overtook those vessels such as happened to the *Victoria*. He had considered it to be his duty, not only to his constituents, but to the House and the country, to put forward his views on the present occasion. (Hear, hear.) He did not wonder that the Admiralty could not get engineers to go on their ships, though they were advertising for men in all the towns in the Midlands. Why? Because it was well known to engineers throughout the country that the poor men at Barrow had to get a life-policy before they would go on boats fitted with the water-tube boilers. The Government should no longer wonder why they could not get men for their ships when they put such dangerous fittings into them (Hear, hear.) He considered it a duty which he owed to the Admiralty themselves thus to speak his mind on a subject which was fraught with the gravest import to the strength and efficiency of our Navy, and to the credit of British engineering. (Cheers.)

Mr. Forwood remarked that he was sure the House had listened with great pleasure to the speech just delivered. (Hear, hear.) The honorable member for Gateshead had dealt with a technical subject, and one very difficult to bring home to lay minds, in a most picturesque and interesting manner, and he was sure that the words which had been uttered by him were weighty ones and well worthy of serious and anxious consideration. He only regretted that the honorable member had not been present when the estimates for the construction of the *Powerful* and the *Terrible* were first brought up. On that occasion he expressed an opinion on these water-tube boilers, not certainly on the lines of the honorable member for Gateshead, but anxiously pressing on the government to have them first tested on a smaller and less important vessel; and, as a shipowner and a layman, he was certainly of opinion that the government ought not to have put these boilers into our two biggest cruisers till adequate trials had been first made in a smaller vessel. An engineer officer was sent out as a passenger by one of the boats to see how these boilers worked, and he made a very valuable report, but the *data* was not of the kind on which the Admiralty could embark with experiments. The only advantage was that they lend themselves to be placed in a ship, and stood more conveniently than ordinary cylindrical boilers. He should like to say that one of the last actions of his noble friend, when chief of the Admiralty, was to order a torpedo-boat with a water-tube boiler for experimental purposes. The order was given to Thornycrofts, and they were given a free hand. They guaranteed that the boiler would be efficient for at least three years. He thought that was a proper course to take, and it was right that the Admiralty should watch all new inventions. The member for Gateshead had made a sweeping attack upon the boilers generally in her Majesty's ships, and if that attack were passed over it might cause alarm. There was no doubt that at one time there was an inclination to cut down the size of boilers and force them to give larger H.P. than, as it had since been proved, was practically possible. They had then at the Admiralty probably the most able theoretical engineer that ever lived, but his great *forte* was theory rather than practice. His great desire was to unduly cut down engines and boilers, in order that a vessel might hope to be propelled at a higher rate of speed and be built on finer lines. The result of that policy was that several vessels, the *Blenheim*, the *Blake*, and the *Vulcan*, had not proved satisfactory. The boilers would not stand the forced draft for which they were originally designed. When the Naval Defence Act vessels were laid down it was decided that the boiler power of those vessels should be as near as possible on the lines adopted by the mercantile navy.

Mr. Penn did not think that the alarm expressed by the honorable member for Gateshead (Mr. Allan) in reference to the boilers in the Navy was well founded. His own impression was that as at present designed we did not get enough out of the boilers. It would have been well to have given a longer trial to the water-tube boilers of the Belleville type, but it should not be supposed that these were so many death traps. They had been running now for several years, and would have been condemned long ago if they really were the failures the honorable member seemed to think.

Mr. Robertson said this case of water-tube boilers was an example of the extent with which the Board of Admiralty, whether the naval or civil element was concerned, must be guided by the best professional advice it could obtain. There were hundreds of questions in the administration of the Admiralty with which his honorable friend was not familiar, on each of which they must be guided by professional opinion; but referring to the engineering advisers of the Admiralty, his honorable friend spoke of them as belated something or another. (Laughter.)

Mr. W. Allan: "No; I never used such a phrase as that. I merely wanted to know who was responsible for the adoption of the Belleville boilers to such an extent."

Mr. Robertson: "Certainly, I am going to answer that question. His honorable friend was himself a little belated in bringing this question before the House, because the adoption of the Belleville boiler was no new thing. It was mentioned a year ago to the House of Commons, and was matter of notoriety in all sorts of ways. Not long ago the Engineer-in-Chief of the Navy read a paper before the Society of Civil Engineers, in which this matter was expounded before experts and people of skill, and the thing passed apparently without discussion, certainly without disapproval, among men who were entitled to speak with as much authority as his honorable friend. The history of the subject, so far as the Admiralty were concerned, was this. In 1885 a torpedo-boat was first of all fitted with these water-tube boilers. In 1888 three torpedo-boats meant for Indian service were similarly dealt with. In 1892 another torpedo-boat was fitted in like manner. In 1891 the *Speedy* was fitted with water-tube boilers with satisfactory results, and in 1892 the Boiler Committee, which gave special advice to the Admiralty, recommended the adoption of these boilers for the new cruisers, and the *Sharpshooter* was fitted with Belleville boilers and another vessel with water-tube boilers of another type. Then the Admiralty sent out that despised Frenchman—who, by the way, was no more a Frenchman than the honorable member for Gateshead was (laughter)—they sent an engineer officer to examine the working of these boilers on board the large ships belonging to the Messageries Maritimes, and that officer no doubt spoke French; but, as he was to be on board French ships and to talk to French engineers, they considered that that was rather a qualification for his mission. (Laughter.) This officer went to Australia and back, and his report on the working of these boilers was entirely satisfactory. The next step was that the Committee on Machinery Designs expressed satisfaction at the proposal to use Belleville boilers for the *Powerful* and the *Terrible*. In the circumstances he could not see how the Admiralty could have acted otherwise than they did. Sir William White's opinion was in favor of these boilers, and the House, he was sure, would receive with respect his testimony, even on a point of technical engineering. But there was a more important authority still—namely, the Engineer-in-Chief of the Navy, Mr. Durston, who was really responsible for the adoption of these boilers. The Admiralty, he affirmed, had dealt with this matter as they were bound to deal with all technical matters. He would say, generally, however, that the honorable member for Gateshead was wrong in what he had said respecting the *Blenheim*, the *Viking*, the *Blake*, and the *Hornet*. He trusted that the House would be of opinion that he had vindicated the action of the Admiralty, inasmuch as he had shown that the Board had sought the best advice obtainable, and had acted consistently upon it. The Admiralty were told that the benefits of these boilers were higher steam power, less weight for a given steam power, and greater command of steam. Those were specific advantages of which they had professional assurance, and on that assurance they had been introduced into these large ships."

Lord G. Hamilton wished to know if the statement that the boilers had been taken out of the *Hornet* was true.

MR. ROBERTSON said that the tubes were being changed to steel. That was going on while the vessel was under repair.

MR. W. ALLAN asked whether it was not the fact that the boilers were lying in a corner of the dockyard, and the ship open and practically gutted.

Previous to this discussion, in reply to a question by Mr. Gourley, Mr. Robertson stated that of the 42 torpedo-boat destroyers completed and building, all except six are and will be fitted with water-tube boilers. The boilers of nine of these ships were fitted with copper tubes throughout by the contractors, who were responsible for the design and preferred to use that material. In three of the last-named, on the contractors' preliminary trials, failure of the copper tubes occurred in positions most exposed to the fire, and in one case was attended with fatal results. It was consequently decided to avoid further risk by substituting—entirely in some of these vessels and to a large extent in the others—steel tubes for copper.

LORD GEORGE HAMILTON said: "I should like to say a word as to the question raised last night by my honorable friend, the member for Gateshead. My honorable friend attacked the Admiralty for having adopted water-tube boilers. If anybody was responsible for the introduction of these boilers it was myself. And I will state my reasons. An extraordinary improvement has taken place in marine engineering in recent years. But the improvement in boilers has not in any way corresponded to the improvement in machinery. Various experiments to get increased boiler power into torpedo-catchers have not been successful, and therefore it seemed to me that when a firm of high repute guaranteed efficiency for three years it was worth while making the experiment, and the ship intrusted to this firm has been a very great success. My honorable friend drew a pathetic picture of the terrible dangers to which any one was subject who went on board a vessel with water-tube boilers. I have been on board such vessels, and I believe a water-tube boiler is just as safe as any other boiler, provided it has been properly manufactured and is properly managed. The mistake made in this matter arose because the Admiralty had to put out a very large number of torpedo-boats all at once, and they were compelled in consequence to distribute them over many firms who had never built a torpedo-boat before. All the accidents that have occurred were in the work of firms who had no experience of this particular class of boilers. Therefore, I cannot blame the Admiralty. I think they were right in continuing experiments as regards water-tube boilers. They have put them into two of the largest cruisers ever built, and if the result justified that experiment no fault could be found."

MR. WOLF thought that in the question of boilers, so far as his professional knowledge went, tubular boilers had no advantage over ordinary boilers, except that they were a saving of weight. In his opinion the Admiralty were making a most unwarrantable experiment with the Belleville boilers. He never heard of any commercial company that would at once apply one new boiler to the whole of the ships they were going to build. Surely the Admiralty were risking too much in putting the Belleville boiler—not that he thought it was dangerous in itself—into every one of the ships of their programme. He had been told that one advantage of these boilers was the easy manner in which they could be repaired. But that was really a trifling advantage, as they were constantly getting out of order, and it would be far better and cheaper at the outset to put in a boiler that did not want such frequent attention. He hoped that the Admiralty would not too rashly make an experiment with these boilers on a scale so large as to mean ruin to the efficiency of the naval programme.

SIR E. REED replied that the honorable member who last spoke actually stated to the Committee more than once that he did not know what was the value of water-tube boilers as compared with the ordinary cylindrical boilers. There were, he thought, good reasons for the adoption of water-tube boilers. An ordinary double-ended cylindrical boiler would contain from 30 to 35 tons of water, and was ready to explode with terrible violence in the event of any disturbance from outside. Water-tube boilers, on the other hand, would not contain more than a tenth of that quantity of water. Surely that was an intelligible object to accomplish in a ship subjected to the blows of torpedoes and of guns. Then experience and science pointed to the necessity for increased pressure if they were to have greater economy. They had, however, gone as far as they could go with regard to pressure in the case of the cylindrical boiler, but in the case of the tubular boiler they could resort to a much higher pressure. Still, he must say he was a little startled on reading the passage in the First Lord's statement that "it is proposed to adopt boilers of the water-tube type in the new ships to be laid down in 1895–96." That meant that the cylindrical boiler had already been laid aside in favor of a boiler of which they had not had very much experience. The honorable member for Gateshead, with a forcibleness of delivery which would make a man believe almost anything (laughter), had spoken as if boiler accidents were unknown prior to the introduction of the tubular boiler. But there had been many cruel explosions with cylindrical boilers, both in and out of her Majesty's Navy. Then it had been represented as a terrible thing that the tubes should wear out so fast. He admitted that if that was permanent, it would be objectionable, although he did not think that the more rapid destruction of the tubes than of cylindrical boilers would of itself be a reason for giving them up. If they obtained advantages in other directions, they should be prepared to renew the tubes more frequently. He did not wish to express any strong or decisive opinion on the matter, but he believed the government could not have avoided making a considerable and extended introduction of these boilers in the Navy. There might be difficulties, and even accidents, but they must make their tubes as they made everything else—competent for the work they had to perform.

MR. W. ALLAN: "Why did the tubes burst in her Majesty's ship *Sturgeon*?"

SIR E. REED: "I have not the smallest doubt that the tube burst because it was unable to bear the pressure."

MR. W. ALLAN said the tube was tested at 1,000 lbs. per square foot, and afterward at 290 lbs. The pressure at which the boiler worked was 200 lbs., and it did not register that pressure when the tube burst almost from end to end and the fatal disaster occurred.

SIR E. REED remarked that it was a common thing for a tube which had stood a very high hydraulic test to give way under heat. His contention was that if one had a good object to accomplish one must not try to carry it out by insufficient means.

This discussion resulted in calling out a number of communications from prominent English engineers and others, which are very interesting, but which we are compelled to condense.

Mr. Walter H. Maudslay, Chairman and Managing Director Maudslay Sons & Field (Limited), writes to *The Times*, and after saying that his firm are the sole manufacturers of the Belleville boilers in England, he adds politely that Mr. Allan did not know what he was talking about when he made the remarks which are given above, and that he did not take the trouble to inform himself. He—Mr. Maudslay—then went on to say that Mr. Allan has hopelessly jumbled up the Belleville with all other boilers, and, continuing, said:

"Now, roughly speaking, about 60 ships have been fitted with these water-tube boilers, driving engines of a total power of 350,000 horses, and in no case have we ever heard of an accident of any sort; and yet Mr. Allan speaks of the Admiralty as using untried boilers of a most dangerous character, and states that dreadful accidents have taken place with them. . . .

"All the new ships in the French Navy are boilered with water-tube boilers, most of them being of the Belleville type. I give here the names of some of their most important vessels fitted with Belleville boilers: *Bouvet*, 14,000 I.H.P.; *Descartes*, 8,500 I.H.P.; *Pascal*, 8,500 I.H.P.; *Pothuau*, 10,000 I.H.P.; *Galilée*, 6,600 I.H.P.; *Catinat*, 6,600 I.H.P.; *Bugeaud*, 9,000 I.H.P.; *Chanzy*, 8,500 I.H.P.; *Charner*, 8,500 I.H.P.; *Latouche Tréville*, 8,500 I.H.P.; *Brennus*, 14,000 I.H.P.; *Lavoisier*, 14,000 I.H.P.; *Charlemagne*, 14,000 I.H.P.

"The Russian Government have during some years past fitted most of their important vessels with Belleville boilers. For instance the new *Ruriks* and the *Standard* (the new yacht for his Imperial Majesty the Tsar), of 14,000 I.H.P., are among the latest.

"As to our own experience. About two years ago my company fitted with machinery and Belleville boilers the warship *Gremyaschy* at St. Petersburg. Although this was our first attempt, we took this vessel out for her official trial without even one of a preliminary character, and we had an unqualified success. Since then this vessel has been in commission, and with her own Russian stokers has beaten our trial trip records, and that without a single hitch.

"The officials of the Volunteer Fleet of Russia have adopted these boilers, and my company are now fitting 25 boilers in the first of the new vessels to be ordered—viz., the *Cherson*, of 12,500 H.P. We shall also soon be trying the *Egyptian Monarch*, Mr. Wilson, of Hull, having intrusted us with the order for Belleville boilers for that vessel, and we have also fitted some other smaller ships.

"We find also that nearly all the foreign governments are contemplating the Belleville boilers for their new vessels. . . .

"The Messageries Maritimes have all their vessels fitted with these water-tube boilers, and are continuing to order them. . . .

"The truth of the whole matter is this, we must have higher speeds and higher pressures of steam. The old cylindrical boiler has come to the end of its tether. It was all very well with steam up to a certain pressure, but its very construction made it rebel against more exacting requirements. No matter who made the boilers, or how carefully they were made, when driven too hard they began to leak, and nothing could satisfactorily stop them. With Belleville and other water-tube boilers it is possible to have steam of any pressure. They have no rigidity and do not leak. Using a reducing valve, the steam can always be kept up to a higher pressure in the boiler-room than in the engine room, so that if the stoking does for a time fall off the revolutions of the engine keep the same, owing to there always being a *plus* pressure in hand.

"Water-tube boilers are easily repaired. A Belleville boiler can be readily taken up or down any hatch without disturbing the vessel; there is no necessity to drag up the decks to remove a boiler, as is the case with cylindrical ones, with all the heavy expense of pulling up deck fittings, etc.

"The boilers can be repaired in an hour or so, are inexplosible, and if one were damaged during an engagement, it could easily be repaired without putting the vessel out of action, as would be the case with a cylindrical boiler.

"Then, again, if cylindrical are matched against Belleville boilers, fully one-third of the weight is saved by the latter. But the most important feature of all is, perhaps, the rapidity of getting up steam. An ironclad with cylindrical boilers would take from 12 to 18 hours to get steam up; the same vessel with Belleville boilers would have a full head of steam in three-quarters of an hour. Surely this is an all-important feature in time of war.

"With regard to the various types of water-tube boilers of a lighter character, which must not be confused with Belleville boilers, we are all feeling our way. My own company is fitting four vessels of the 27-knot class, which is the speed the Admiralty ask for the torpedo-catchers now building—the new ones, I believe, are to go several knots faster—an enormous advance. With no boilers can this be done unless they are of the water-tube type, as weight down to ounces must be considered."

To this MR. ALLAN responded that if the Engineer-in-Chief at the Admiralty thinks he has sufficient *data* to warrant him to go in for such a wholesale adoption of water tube boilers for vessels building and to be built, he (Mr. Allan) does not, and many others think likewise.

The whole drift of his speech, he says, was that these boilers ought to be subjected to a fair, ocean-going, full-speed test, over an extended period and for long distances—say, in a second-class cruiser—so that all the engineering points involved in working could be ascertained correctly and reported upon by unbiased experts on board, prior to any extended adoption of them, as contemplated in our fleet.

MR. JOHN I. THORNYCROFT also "rose to explain," and, in a letter, said:

"Two statements have been made prejudicial to the interests of my firm, and I would therefore beg for the insertion of a few lines.

"'Mr. Allan has stated that it is not possible to obtain economy in coal consumption in vessels fitted with water-tube boilers. . . . I enclose a table showing the results obtained in her Majesty's ship *Speedy* with water-tube boilers bearing my name. This table not only proves that water-tubes may be economical, but it shows that this particular form of water-tube boiler is capable of yielding results superior to the best of those given by Mr. Durston in his recent paper read before the Institution of Civil Engineers. The *Royal Sovereign*, which is the most economical ship quoted by him, consumes, under natural draft, 1.84 lbs. of coal per I.H.P. per hour, while the *Speedy*, under very similar conditions, consumed only 1.58 lbs. per I.H.P. on a trial of 20 hours' duration. This amply proves that the highest economy is possible with the *Speedy* type of boiler. This boiler has also the advantage of being remarkably light, although adapted for a high steam pressure. Again referring to Mr. Durston's paper, where details of the machinery of vessels of the *Speedy* class are given—and it must be remembered that in these vessels particular attention has been paid to reduction of weight—it will be seen that the I.H.P. developed per ton weight of boiler averages in the case of the locomotive type 29.5. In the Belleville, as fitted in the *Sharpshooter*, it is 26.1, while in the *Speedy* it is 43.9. It will be seen that the French boiler is compared to some disadvantage, as the locomotive is the lightest of internally fired boilers, for in the *Royal Sovereign*, which has cylindrical boilers, the I.H.P. per ton is only 22.3. This shows that boilers of the latter type require to be twice the weight of those of the *Speedy* type for a given power.

"Mr. Maudslay says that 'with regard to the various types of water-tube boilers of a lighter character, which must not be confused with the Belleville boilers, we are all feeling our way.'

"However true this may be as regards Mr. Maudslay's own attitude, I cannot accept this description as correctly applying to my firm, for the boilers we are fitting in destroyers are of a well-tried design."

A correspondent who signs himself "NAVALIS" "goes for" Mr. Maudslay, who the correspondent says,

"Brings forward, as examples of success, a list of 13 ships of the French Navy as 'fitted with Belleville boilers.'

"Omitting a clerical error, by which he describes the *Lavoisier*, an unfinished third class cruiser, as having engines of 14,000 H.P., there remain 12 war vessels, none of which have as yet completed a satisfactory and final trial, and about half of the 12 are still in embryo."

MESSRS. YARROW & Co are also heard from, and testify that "from our own experience, and from what has been accomplished in France, we believe there can be no question that water-tube boilers are destined to be largely introduced in the course of time, and the benefits secured are such as to render them specially desirable in the case of war vessels. In some forms the water-tube boiler is much lighter, safer under the high pressures now demanded, more easily repaired (without the necessity of taking to pieces a large portion of the vessel), they require less skill in stoking, admit of raising steam with greater rapidity, and as regards economy of fuel are either on a par or superior to the old forms.

"Although we sometimes differ from Mr. Durston, the Engineer-in Chief of the Navy, on this point we do not. We believe, as we have often stated in public, that the action of the Admiralty in selecting water-tube boilers—undoubtedly a very bold step—will be recognized in the future as correct, and later on the wisdom of the course adopted by the authorities lending official sanction to one of the most important advances in marine engineering will be fully appreciated. . . .

"We are not speaking from any interested motive, as we make boilers of both classes; but we feel bound to defend a policy which we believe correct, from whatever source it emanates."

MR. FORTESQUE FLANNERY writes:

". . . How far the Admiralty is justified in deciding to fit, not one, but two of the largest cruisers with boilers of this type later events must show; but there is no doubt that if the *Powerful* and the *Terrible* steam satisfactorily with their water-tube boilers they will be the first large vessels under the British flag, either in the royal or mercantile navies, that have done so. The ordinary course of a shipowning company would be to try one vessel of medium size first, under every possible condition of high pressure and full speed, for a period of a few months, and to be guided by results before extending the use of a hitherto untried device. Having regard to the number of comparatively small vessels at present at the disposal of the Admiralty the boilers of which are nearly worn out, it would seem a reasonable course that one of such vessels should have been selected, 'Belleville boilers' put in at an expenditure of time of only a few months, and a thorough test made under the immediate guidance and control of royal naval officers with a ship in commission during at least one voyage at full speed. . . .

"The results, more or less encouraging, of water-tube boilers of different types in the torpedo-catchers throw only a distant light upon the 'Belleville boilers,' as the construction is in many respects substantially different."

MR. JOHN D. ELLIS, Chairman of John Brown & Co. (Limited), in response to what he calls "the public reiteration," that the cylindrical boiler has come to the end of its tether, says:

"At present this statement is not warranted by the actual condition of things.

"The Yarrow, Thornycroft, and kindred boilers may be all that is claimed for them for torpedo-boats and similar vessels, but for large war, passenger, and cargo ships the makers of the Belleville and similar boilers are not likely to find the cylindrical boiler dead, as they apparently wish every one to believe.

"Mr. Allan has spoken of the safety of natural draft and considers 'forced' draft 'unnatural' draft. Certain well-known troubles have, no doubt, been experienced in the application of forced draft to cylindrical Scotch and locomotive boilers with large nests of small plain tubes closely packed, but it does not follow that with large diameter tubes, ample water spaces, ready escape of steam, and strong mechanical

suction draft, which in its action upon the boilers is the same as natural draft, the same difficulties will occur. As a matter of fact there is already nearly four years' experience that with this suction draft it is perfectly safe and convenient to obtain from cylindrical boilers two to three times the amount of the work obtained with natural draft, and from the absence of troubles at these rates of combustion it is clear they may be still further increased. The 'Serve' tube having twice the internal heat-absorbing surface of the plain tube of any given diameter, has, moreover, enabled—even for the highest rates of combustion—the use of large diameter (3¼ in.) tubes with large water and steam spaces. The economy arising from the use of the Serve tubes with retarder is increased by heating the air with the heat of the waste gases, and the result is that these cylindrical boilers, even at three times the ordinary combustion of natural draft, give an evaporation per pound of fuel equal to current practice with natural draft and plain tubes, which shows a considerable economy over that of the ascertained results of the Belleville boiler.

"Even at only twice the combustion of natural draft with ordinary funnel height the cylindrical boilers occupy less floor space than the Belleville boilers for a given I.H.P., and when we come to the weight question the great difference in the coal consumption per I.H.P., moreover, is to the advantage of the cylindrical boilers in all long-voyage vessels, surprising as this may be to some of your readers accustomed to hearing one side only. Mr. Howden wished to make a trial between the Belleville boiler and the cylindrical boiler with his system. Comparative evidence exists already close at hand establishing the great economy of the cylindrical boiler even under less favorable conditions than with his or the still more economical suction draft system referred to above. The London, Brighton & South Coast Railway have two new steamers running between Newhaven and Dieppe. The *Seaford*, built by Messrs. Denny, has cylindrical boilers, ordinary Serve tubes, plain stay tubes, and closed stokehold forced draft, which is the least economical of mechanical drafts, because it does not utilize the waste heat of the gases after they leave the boiler. The sister ship, *La Tamise*, was built in France and fitted with Belleville boilers. They both develop the same I.H.P. and have the same speed, but the *Seaford* averages 27¼ tons of coal per trip, and the *Tamise* 37¼ tons. Let the owners of long-voyage steamers or of Atlantic racers calculate for themselves what this would mean to them.

"The system of suction draft with cylindrical boilers referred to is working well in Australian and Atlantic steamers—in some at 200 lbs. working pressure with quadruple engines. The Belleville boiler works at 250 lbs. pressure, because it is considered more economical to do so than at a lower pressure, and by means of a reducing valve the steam is supplied to the engines also at 200 lbs. The susceptibility to quick considerable variations in pressure because of the small steam storage is thus counteracted in the Belleville boiler, but the cylindrical boiler with large steam space has no need for this.

"Much is made of the facility of repairs, as if these were expected to form an important feature. If, however, the tubes and furnaces of a cylindrical boiler should require replacing, there is no difficulty whatever in doing so, and even if the Belleville boilers for any given I.H.P. were to last as long as a cylindrical boiler—an assumption which has yet to be demonstrated—I venture to say that the advantage resulting during the life of the boilers from the much smaller weight of coal used and carried will far more than compensate for the extra cost in taking cylindrical boilers out of and putting new ones into the ships.

"Not even the feature that steam can be raised 'in an emergency' in half an hour can be claimed as the special property of the Belleville boiler. The same has been done with perfectly cold cylindrical boilers fitted with this system of draft, without evil consequences, in practically the same time."

To a question proposed by Mr. Wolf in the House of Commons, who asked for information about the boilers of the *Sharpshooter*, Mr. Robertson said: "The *Sharpshooter* was fitted with eight Belleville boilers 12 months ago, and these were first tried on board under steam in February, 1894. Seventeen steam trials were made at various powers and durations up to 30 hours. The ship was commissioned in September, 1894, and while on service with the Channel Squadron has made two special 12-hour trials and the usual quarterly 24-hour trial, and the result as regards the Belleville boilers has in each case been most satisfactory."

MR. C. JOHNSTONE, among other things, says:

"As a sea officer I am looking at the matter only as it concerns the public interests represented by the Navy, and I believe the introduction of these boilers to be a step as advantageous as it is important. . . .

"I will not attempt to argue this question as presented by theoretical engineers. I look at it from the man-of-war's man's point of view, and consider that if these boilers will stand wear and give the required speed we may make the advocates of cylindrical boilers a present of all the advantages they claim. Are the water-tube boilers, taken generally, more expensive of coal? do they occupy more space? Be it so, we will accept that; but what we want in the Navy is boilers which:

"1. Will raise steam quickly.

"2. Can be renewed without pulling important parts of the ship to pieces.

"3. Will not suffer much from small projectiles.

"4. Will not explode with most disastrous effects.

"All these needs, I understand, the water-tube boiler supplies. This has not reference to any particular make—to this boiler or that boiler—but to the type of boiler which contains its water in small spaces." . . .

Another correspondent, who signs himself "M.," criticises Mr. Maudslay's statements as follows:

"The worthlessness of Mr. Maudslay's list of French warships fitted with Belleville boilers as proofs of actual performance has been pointed out. The fact is that the working experience in that Navy is limited to the *Alger* and a very few low-powered and comparatively unimportant vessels, and proved too slender to enable the authorities to make a success of the trials of the *Brennus*. These trials have been criticised, and Mr. Maudslay has not averred that the ship realized her legend power of 14,000 H.P., although her boilers occupy an enormously larger space than those of the *Sans Pareil*, which exceeded that power on trial. The space occupied by the boilers of the *Charlemagne* is 50 per cent. greater than that allowed in our new battleships. And the fact remains that in the new cruiser *D'Entrecasteaux* cylindrical boilers are to be installed.

"Mr. Maudslay's references to the Russian Navy are just as worthless. The Russian Government has not, as he says, 'during some years past fitted most of their important vessels with Belleville boilers.' The three ships of the *Sinope* class, the three of the *Poltava* class, and the *Georgi Pobiedonosetz*, *Tri Sviatitelia* and *Dvenadsat Apostolov* are all important vessels, and they all have cylindrical boilers; so are several others. The ships that have the Belleville boilers are the old cruiser *Minin*, two or three yachts of small power, and the three vessels of the *Gremiastchy* class. The latter warships are described in the *Naval Annual* as armored gunboats of 1,500 tons displacement and 2,000 H.P., no criterion whatever for powers 12 times as great.

"Mr. Maudslay contends that the Belleville boiler is necessary if higher pressures are to be used; that the cylindrical boiler leaks, and has got to the end of its tether. The fact remains that cylindrical boilers, in the mercantile marine, as large as 16 ft. in diameter are used for pressures of 200 lbs. per square inch, and are worked both under natural and forced draft without leakage. If the Admiralty cannot go beyond their present standard of 155 lbs. pressure without leakage it is the fault of the designers of the boiler, who persistently refuse to take a hint from mercantile boilers built for forced draft. And in any case the Belleville does not supply steam at 200 lbs. pressure to the engines in any ship to which it has been fitted.

"Mr. Maudslay says that all the Messageries Maritimes Company's steamers are fitted with Belleville boilers; the fact is that seven out of a total of 57 are so fitted. Four of these form the line to Australia, upon which the superiority of the boiler is held to have been proved. Now the two fastest P. & O. steamers—*Australia* and *Himalaya*—frequently run from Brindisi to Adelaide at speeds of 16 to 16¼ knots, and the latter has run from Bombay to Brindisi at about 17 knots (excluding Canal). They have practically the same engines as the Messageries Company's boats, and cylindrical boilers with 500 sq. ft. of fire-grate, while the least powerful of the French boats has 624 sq. ft. Although the latter are much longer and finer ships, they do not maintain any such speeds, the average of the round voyage being under 15 knots; not that they cannot steam faster on a pinch, but presumably the coal consumption is so utterly ruinous when the ships are driven that it is not attempted. These matters have been fully dealt with elsewhere, and Mr. Maudslay made no attempt to traverse the criticisms levelled at the boiler. The Messageries Company, with the strongest possible inducements to run their boats at the highest practicable speed, run them at one altogether incommensurate with their great length, fineness of form, power and quality of their engines, and extent of their boiler installation; and an engineer accustomed to mercantile marine

procedure would have seen the fallacy of the thing directly. From Mr. Robertson's argument it would appear that M. Gaudin was sent to judge by what he was told, not by what he saw.

"The Belleville boiler has been tried in the United States by an engineer who is described in Mr. Maudslay's advertisements as having had years' experience with it, and knowing more about it than any one in America. In fitting it to a large, fast Lake steamer of the same power of engine as the Messageries boats this experienced engineer increased the number of boilers from 20 to 28, and the grate and heating surfaces by 30 per cent.; but the current issue of the *Engineer* states that she has so far failed that the order for a similar set of boilers for a sister ship has been suspended. In the mean time, a large Atlantic liner, with practically identical engines, and cylindrical boilers working under forced draft, and supplying steam at 200 lbs pressure, is working most successfully, her boilers occupying just half the floor space of the Belleville boilers in the Lake steamer.

"To sum up: The Admiralty decided on Belleville boilers for the *Powerful* before they had acquired any experimental information of their own as to their capabilities, and the subsequent trials of the *Sharpshooter* have thrown no additional light on the matter. The performances of the *Alger* have not enabled the French naval authorities to make successes of the trials of the *Brennus* and *Latouche-Tréville*, as far as they have gone. It has not been found practicable to work the Messageries Company's boats continuously at a higher than 5,000 H.P., and an American engineer of experience, who added largely to their boiler capacity to develop their trial powers in ordinary working, has not succeeded in attaining his desires. The engineer sent to investigate the working of the boilers in the Messageries boats was devoid of the experience which would fit him to make a report of any value on their behavior as compared with cylindrical boilers under similar conditions, and yet the Admiralty persist in taking a leap in the dark, not only in these two ships, which are of vital importance to the safety of the nation's commerce, but in other ships to be laid down. Nothing more unjustifiable has ever been attempted since we have had a steam Navy."

This discussion will probably interest engineers in this country as much as it does those on the other side of the Atlantic, which must be our excuse for devoting so much space to it.

YARD ARRANGEMENTS ALONG HEAVY-TRAFFIC HIGH SPEED RAILROADS.*

By A. Flamache.

(*Concluded from page* 180.)

JUNCTION STATIONS.

These are stations where more than one line enters, and where there is sometimes a considerable amount of transferring of passengers and freight. These stations have important local installations, and the entrance of trains for side-tracking or switching is always made head on.

The service of junction stations, viewed from the standpoint of the main line, includes:

1. The passage of through trains.
2. The entrance and exit of local passenger trains running over both the main line and the branches.
3. The side-tracking of slow trains.
4. The entrance and exit of freight trains.
5. The switching and handling of freight trains.
6. The service of the freight yard and factory sidings.

The Entrance and Exit of Local Passenger Trains.—This portion of the service necessitates certain arrangements, the forms of which may differ greatly. In our opinion the best disposition that can be made of the tracks is that shown in fig. 34.

If the branches are situated in the same manner relatively to the main line, there is nothing to prevent their reuniting in a single common trunk (as is actually done, except in the case of an important track), and then to divide the arriving and departing tracks into a certain number of tracks that run in alongside the platforms.

The number and arrangement of the local tracks depend upon the special service of the station. Some local tracks can be used for both arriving and departing trains. Furthermore, it is sometimes possible to permit, without involving any serious hindrance to the service, that local trains running over the main line can stop on the main tracks that run alongside platforms built for this purpose. There are other reasons that may permit of the reduction of the number of local tracks that can be examined for each individual case.

The network of local tracks will connect at one end of the station or yard with the main tracks in such a manner that it is possible for trains to run in from the branches to the main line as well as in the opposite direction. Finally, in order that the track *A* may not be unnecessarily crossed by the trains running along track *B*, it is well to construct a special siding for *B*, along which platforms should be built for the accommodation of local trains running on *B*, as shown in fig. 34. The side-tracking of trains on *A* is done on the local tracks, and merely

FIG. 34.

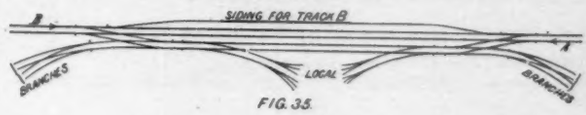


FIG. 35.

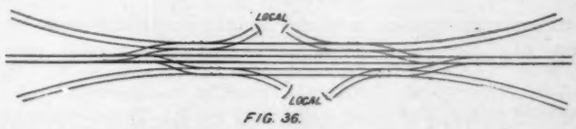


FIG. 36.

calls for the addition of an exit switch *a b*. If the branches approach the main line from different directions, but are still upon the same side of it, the preceding arrangement, as shown in fig. 34, is doubled, as in fig. 35. The same thing occurs if there are branch lines debouching from both sides of the main line; but it will readily be seen that a greater complication is involved.

When some of the branches are single track, they are brought together by the common method shown in fig. 37. The first is especially applicable when the single-track branch turns off to the right. The second is shown, in this case, with the two connections made by means of a cross-over. It is, nevertheless, to be recommended when the single-track branch leads off to the left.

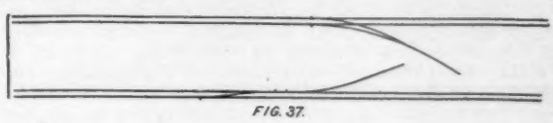


FIG. 37.

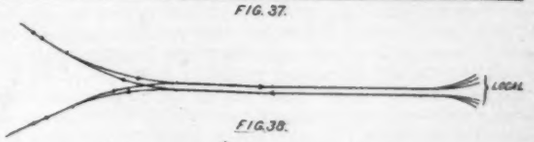


FIG. 38.

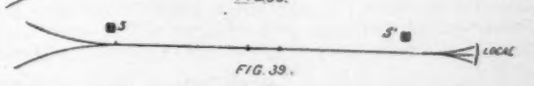


FIG. 39.

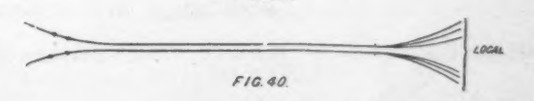


FIG. 40.

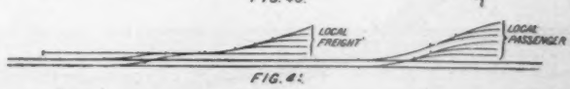


FIG. 41.

When all the branches of the same section are single-track, there is an advantage in not bringing them together before running into the station. The arrangement shown in fig. 38 requires a great deal of special apparatus, and is not favorable to the service, at least, if it be the single-cabin *S* and not the station *G* that controls the single-track blocking on the two trunks. The arrangement given in fig. 39 is dangerous, unless there is established a single-track block between the cabins *S* and *S'*, independently of the simple single-track block. Under all conditions the arrangement of fig. 40 which carries each branch up to the starting-point of the local spurs, is the best.

It should be possible to use the local tracks for freight as well as passenger trains, but there is no reason why special tracks should not be reserved for the former. It is nevertheless necessary that the lay-out should be in good shape. The arrangement in use at the Belgian stations, which separates the local passenger service from that of the freight, offers

* Bulletin de la Commission Internationale du Congrès des Chemins de fer.

especial facilities to the local traffic, but has serious disadvantages when viewed from the standpoint of the main line, as shown in fig. 41. A greater total number of signals in connection with the main line, double the number of point switches and cross-overs, an uninterrupted succession of signals necessitated by this apparatus, creating confusion in the minds of the drivers of fast trains, are some of the main defects of this arrangement from the standpoint of the passage of high-speed trains.

The connection of the local freight service, by means of a

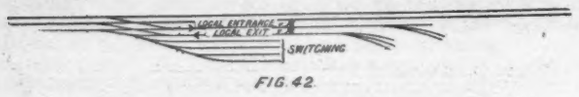


FIG. 42.

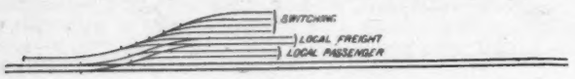


FIG. 43.

FIG 44

FIG 45

twofold change of track placed on a blind siding, causes a very serious delay to freight trains. The impossibility of stopping the switching work at the scheduled time for the arrival of these trains, their time being only approximate, it follows that the freight trains are often stopped at the entrance to the yard, where they obstruct the main lines, while waiting for the switching work to be completed and the sidings to be cleared. The main line thus remains blocked during the whole of this time.

of necessity, especially where the local switching work is of little importance. The arrangement shown in fig. 42, in which the special tracks are reserved for the entrance and exit on the one hand, and for the switching on the other, of freight trains, amply fulfils the conditions laid down above. It will be noted that the entrance and exit tracks are in the same position as the switching tracks, when viewed from the standpoint of the general service. The local service of this arrangement presupposes the common use of the same track by both passenger and freight trains, but there is no reason why it should not be doubled, as in fig. 43.

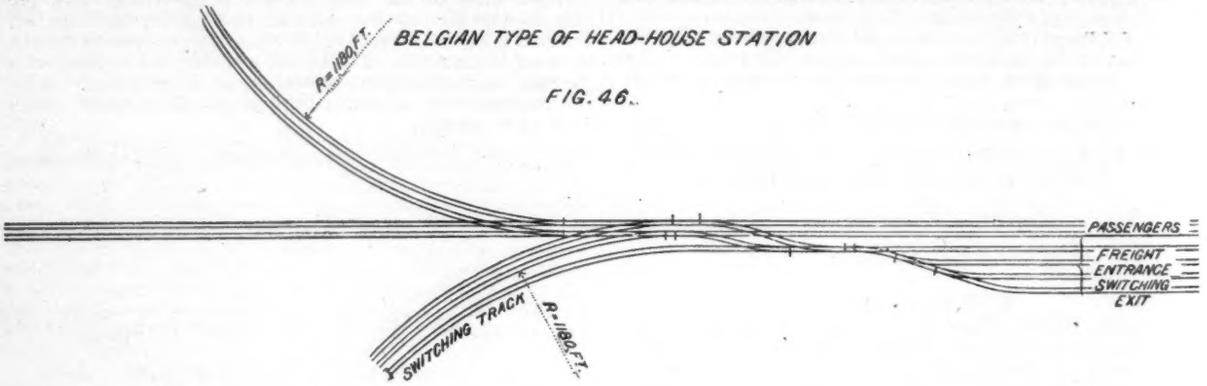
The advantages of the preceding arrangements are at once apparent; the distance between the extreme switches is reduced to a minimum; it is equal to the greatest length of trains which run over the line increased by the length of the connections at the end; the local tracks and the switching tracks are separate—that is to say, switching movements can be freely carried on while trains are running in and out. The latter are, therefore, never kept standing on the main lines.

This arrangement can be criticised from the fact that it does not permit a train to enter or leave either one of the switching tracks at will. In point of actual practice there is no real foundation for this criticism. It is necessary to leave some of the tracks of the switching spurs free for the entrance and exit of trains; the last movement will consist of backing a train out upon the exit track. It is evidently necessary that this *cul-de-sac* should be long enough, so that it will not be necessary to allow a train to stand or to do any switching upon the main lines.

It is furthermore possible to design mixed arrangements, of which figs 44 and 45 are examples, which possess certain facilities. There is nothing to prevent the method of connection shown in fig. 41 being adhered to in the case of branches of minor importance. Fig. 47 illustrates a station of the head-house type, laid out so that the rights of the main line shall be respected, while the branches are treated in accordance with the actual requirements of the individual case. The entrance and exit of freight trains running over branches that lead in on the opposite side of the main tracks from that on

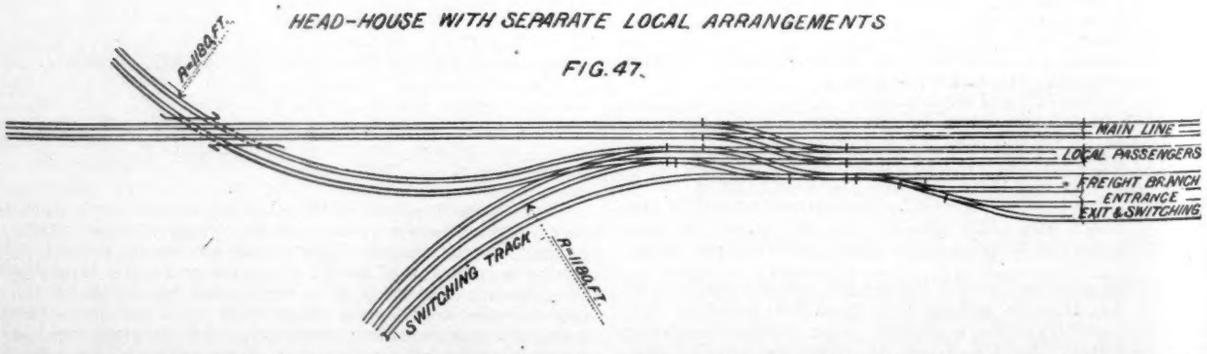
BELGIAN TYPE OF HEAD-HOUSE STATION

FIG. 46.



HEAD-HOUSE WITH SEPARATE LOCAL ARRANGEMENTS

FIG. 47.



Again, the complete interruption of the switching work every time a train enters or leaves the yard will cause serious losses of time to the yard gang. Finally, switches and points that are constantly traversed on a down grade in the switching work, necessitating the constant use of the brake, are rapidly worn out and are impossible to maintain. The result is that derailments are of frequent occurrence, and each one has the effect of obstructing the main line.

The complete separation of the switching tracks from those used for the entrance and exit of the freight trains is a matter which the local tracks are situated evidently necessitates the crossing of the main line. This can only be avoided by the use of a bridge or under-grade passage, as will be shown later on. Unfortunately this method of track construction is almost always impossible to execute, at least from a financial standpoint, where the changes of important stations that are already built would call for very heavy expenditures. In most cases the engineer is compelled to content himself with joining the branches to the main line by connections that are reduced to those found to be absolutely necessary. It is, of course, evi-

dent that the local passenger service should always be on the same side as that from which the branches lead off, unless this is absolutely impossible. A couple of examples of yards laid out in accordance with these principles are clearly shown in figs. 48 and 49. The switches *p q* serve for the local incoming traffic, while the switches *m n* allow the departing trains to run out on to the branch.

FIG. 48.

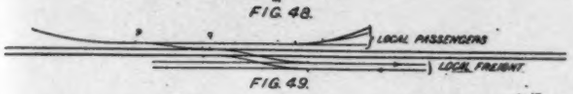


FIG. 49.

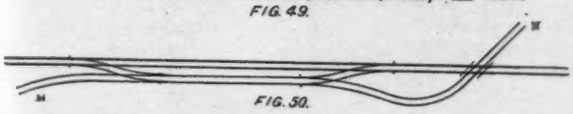


FIG. 50.

The more or less serious difficulty which is involved in connecting the local freight tracks with branches debouching from the opposite side of the main lines, without introducing numerous switches and signals into the service, will evidently oblige us to put the local freight tracks on the same side as that from which the greatest amount of traffic is run out, in order that the main line may be crossed by as small a number of trains as possible; but relative considerations at the yard limits often require the installation of such apparatus. There is a tremendous advantage in carrying all branches from the side on which they must necessarily be started over or under the main line, as shown in fig. 47. This arrangement, though always handicapped by the expense, should be carefully considered. It possesses especial advantages when certain trains are to be run direct from *M* to *N*, or *vice versa*, especially when these trains are slow ones (fig. 50).

I even think that in case of the impossibility, either financial or otherwise, of constructing an overhead or underground passage, that it would be advantageous, from the standpoint of the main line service, to carry the branches across at grade from the side on which the local tracks are situated, well in advance of these later, and consequently away from the switching and yard work. A complete cross-over, laid down with especial care, and protected by a good system of signals, seems to me to present fewer dangers than a direct entrance into the station.

Freight Yards.—As we have said at the beginning, little attention will be paid, in this paper, to local tracks where their arrangement has no effect upon the main line. The outline of the arrangements for loading, etc., in the diagrams that follow are of no interest, then, beyond their actual connection with the main lines.

In the majority of lay-outs the freight yards and local tracks are connected directly to the main lines upon which they stop for local loading and handling. This arrangement conforms to the spirit of this work where the main line is considered as the principal artery of the local service, but is bad, when viewed from our standpoint, and should be replaced by some other in which the main line is reserved for the exclusive use of high-speed trains that pass without stopping.

The freight yard should, therefore, be connected to the local tracks on its own side, and the necessary connections be further established between these local tracks, so that the trains which

FIG. 51.

are occupying them can drop or take on cars and do such other switching work as may be necessary. When the freight yard is on the same side as the slow freight, the connection is easily made (fig 51).

FIG. 52.

Two local tracks, *A'* and *B'*, which are devoted to this service are connected with the freight yard in the usual manner, and it is upon these tracks that the trains must stop, leaving the main line perfectly free. When the freight yard is upon the opposite side of the local system for slow trains, it can be connected with the local passenger traffic, if there is one on that side, or with a doubling up of the main-line tracks (fig. 50).

A train running over the main line *B* enters the double siding *B'*, and does its work there without in any way hindering, by its presence, the work on the main line. It is also well to locate a blind siding at *c* which has sufficient length, so that the switching work can be carried on without trespassing upon the exit connection *r s*.

FIG. 53.

FIG. 54.

FIG. 55.

On the part of the main line *A* a train enters the local track *A'*, and can then switch its cars over into the freight yard by using the cross-over *M N*. If a train that is occupying *A'* has to be broken up or the cars rearranged, it is best to perform these secondary manœuvres on the switching tracks rather than in the yard proper. It will be noticed that the two tracks of the main line must be crossed each time that any transfer is made from *A'* to the yard. This last movement, which would otherwise be necessarily repeated, should only be made once.

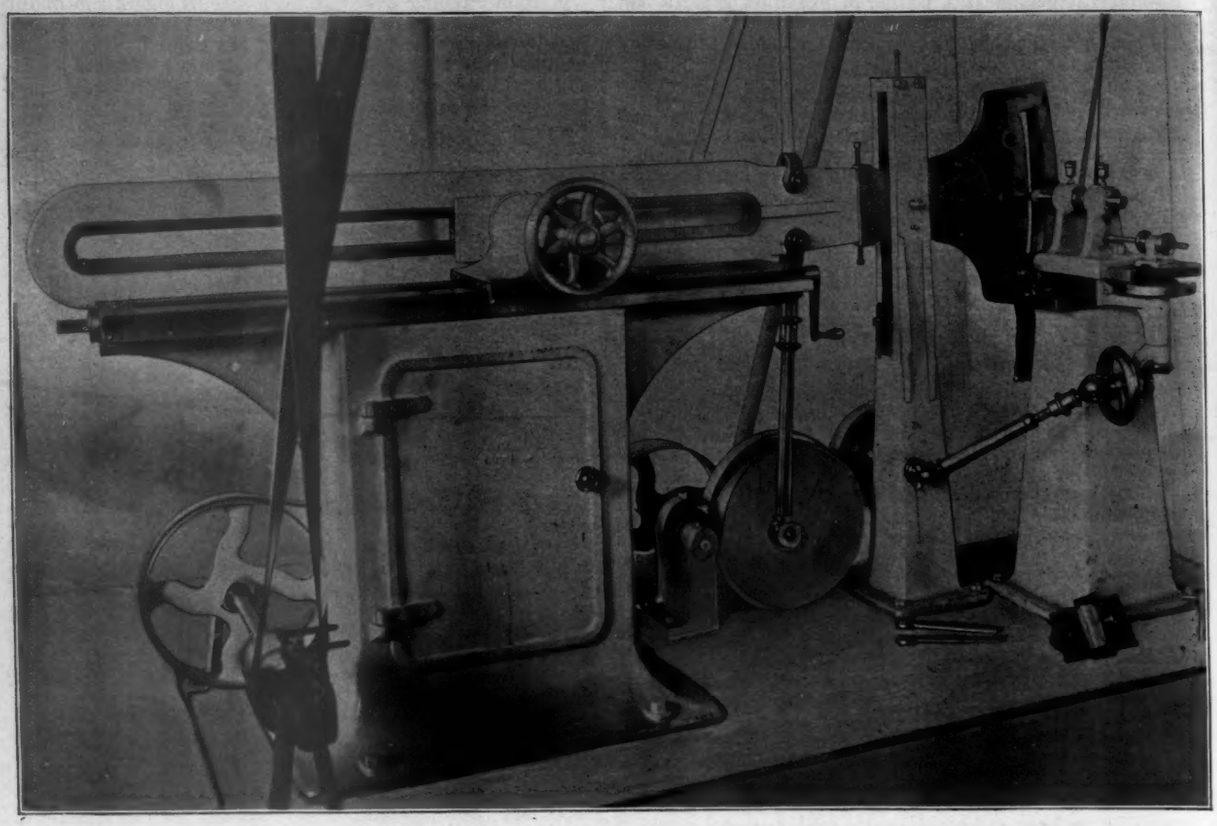
The location of the freight yard on the same side as the local tracks for slow trains has some advantages from the standpoint of the main-line traffic, but this method of grouping is almost always practically impossible, because the switching tracks are, for the most part, generally placed on the opposite side from the most thickly settled part on account of the cost of land, while the loading tracks and freight sheds are more conveniently placed on that side in order to avoid unnecessarily crossing the tracks by trucks and drays which are used for hauling freight to and fro from the depot.

Engine Service.—If trains are compelled to change engines, or the latter are to take on water or coal, it should be so arranged that they can stand upon the local tracks while this is being done. Consequently this work with or for the locomotives has no special interest from the main-line traffic standpoint. In conformity with what has already been said, great latitude should be permitted the station and traction service in these particulars, with the important restriction that they shall keep well off from the main lines. In this respect it is not advisable to imitate the arrangements very commonly used in the Belgian stations, which places the roundhouse and the engine yard on the opposite side, relatively to the main line, from the point where the locomotives are used.

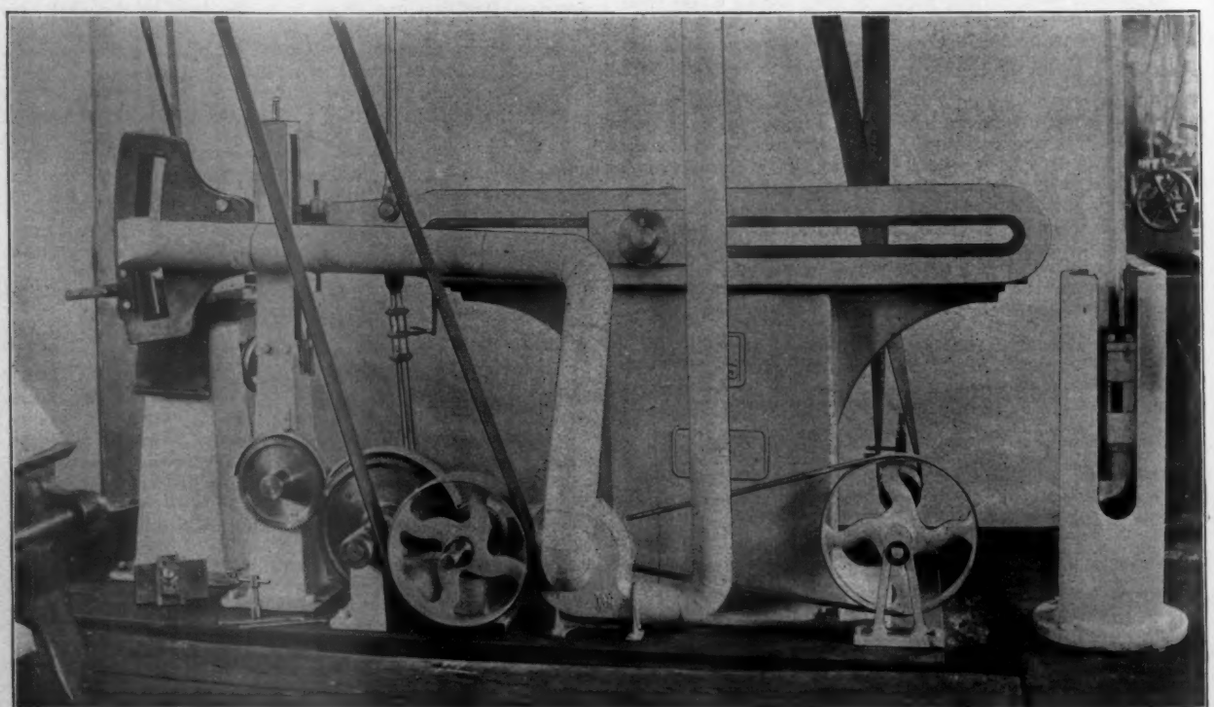
SUPERHEATED STEAM IN ELECTRIC-LIGHT STATIONS.

The difficulties caused by the condensation of steam in steam-pipes and in cylinders are, of course, not by any means new, but the conditions of the public supply of electricity render it especially desirable to procure steam in as dry a condition as possible at the engines. Professor Unwin called attention to the Determination of the Dryness of Steam, in a paper recently read before the Institution of Mechanical Engineers, and described several methods of testing the dryness factor. The conditions of work in an electric-light station are, of course, peculiar. The output of energy is very far from regular. In the winter a sudden fog may call for a supply during the daytime equal to the maximum output usually needed in the evening. In order to meet this demand some of the boilers must always be kept with fires lighted, so that steam may be got up in a few minutes, while it is impossible to avoid putting an extra load upon some of them during a period of great demand.

We know of no type of boiler which will give off dry steam when worked up to its maximum output, for it is certain that the harder a boiler is worked the greater is the chance of water being entrained by the steam. Great trouble had been



FRONT VIEW.



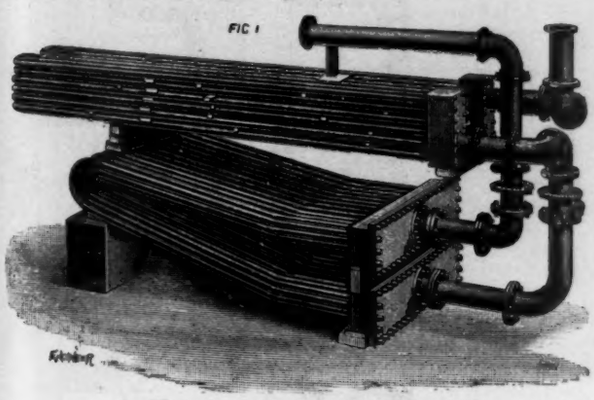
REAR VIEW.

LINK GRINDING MACHINE, GRAND TRUNK RAILWAY.

caused by wet steam at the electric-light station in Maiden-lane of the Charing Cross & Strand Electricity Supply Corporation, Limited, and Mr. W. H. Patchell, the Chief Engineer, found himself obliged to have recourse to some method for drying the steam. In this station the steam-generating plant consists of seven Babcock & Wilcox boilers, six of the size known as 160 H.P., and containing nine of 14 tubes. Five of the boilers are in use at once during the period of heaviest load, and when they were pressed the steam delivered to the engines was found to be very wet.

Two of these boilers have now been fitted with McPhail & Simpson's dry steam generators. The first boiler was altered in 1893—and this was, we believe, the first Babcock & Wilcox boiler which had been dealt with by the inventors—and the second one was fitted up last year.

FIG 1



McPHAIL & SIMPSON'S SUPERHEATER.

Fig. 1 represents the apparatus erected complete before being fitted into the boiler, and fig. 2 shows to a smaller scale the arrangement of the apparatus inside the boiler.

In the Babcock & Wilcox boiler steam is collected from the cylindrical steam vessel by an anti-priming pipe, and taken direct to the steam-pipe; but with McPhail & Simpson's arrangement the steam is collected by a similar horizontal perforated galvanized-iron pipe fixed at the top of the steam chamber; it descends in a cast-iron pipe to a strong closed box which is let into the vertical brick bridge above the water tubes. A number of bent tubes are carried in a group through the hottest part of the flame chamber, and return to a second box placed below the first. The steam is therefore intensely superheated as it passes through this set of tubes, and is taken from the bottom box and carried through a second series of tubes in the water contained in the cylinder. The extra heat is there given up by the tubes to the water, and the steam passes out at the stop-valve still superheated and of course perfectly dry.

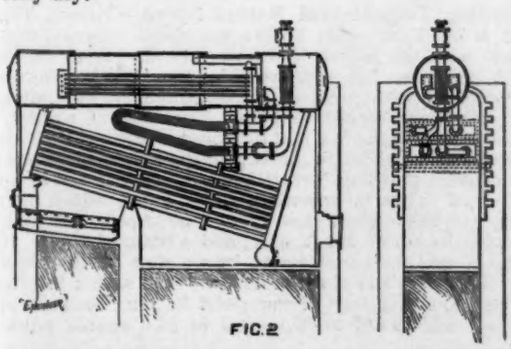


FIG.2

McPHAIL & SIMPSON'S SUPERHEATER ON A BABCOCK & WILCOX BOILER.

The boxes into which the tubes are fitted are made of cast steel, and the tubes in the fire spaces are specially mild steel 1 in. diameter internally, where they are, of course, exposed to the pressure of the steam, but 2 in. diameter in the water space, where the internal pressure is balanced by the external pressure. Each tube is skimmed up true at the ends by machinery, and is expanded into the boxes.

A slight change from fig. 1 has been made in the method of fixing the pipes at the Maiden-lane station. In fig. 1 the steam would pass four times along the length of the upper cylinder; this was considered unnecessary. The centre loops were, therefore, suppressed, and the ends of the tubes at the left of the figure were joined together by a flanged box, so that the steam now passes twice the length of the cylinder. In this way greater facility was obtained for fixing the apparatus. While the boiler is supplying steam there is, of course, a rapid circulation of steam through the tubes of the apparatus, but the moment the stop-valve is closed the contents of the pipes become quiescent, and it would appear that at such a period the tubes in the fire space must be exposed to excessive heating and may become red-hot. We understand, however, that no practical difficulty has been experienced, and we presume that by regulation of the dampers excessive heating can be avoided.

Photographs have been taken which illustrate the appearance of saturated and dry steam. When the photograph was taken steam was issuing from two ¼ in. pipes, which were both conveying steam from a Lancashire boiler fitted with the apparatus we have described, and working at 46 lbs. gauge pressure. The steam issuing from a pipe leading from the stop-valve was almost invisible, showing the improved quality of the steam as compared with that issuing from the ordinary saturated steam space of the boiler. The temperature of the saturated steam was 293° F., and that of the dry steam 392° F. Both the dry and saturated steam were at the same pressure.

The working pressure on the boilers at Maiden-lane is 150 lbs. per square inch, and the area of the stop-valve upon the drum is less than the combined area of the group of pipes.

The following table will show clearly the results obtained from actual tests. Column A shows the absolute pressure of the steam in pounds per square inch at the boiler—that is to say, the gauge pressure plus 15 lbs.; column B, the calculated temperature in degrees Fahrenheit, due to the pressure of saturated steam; column C, the temperature found by experiment at the engine side of the stop-valve boiler and close to it; column D, the rise or fall of temperature obtained:

A.	B.	C.	D.	Remarks.
Lbs.	Deg.	Deg.	Deg.	
166..... ...	366.5	359	7.5	Superheaters not in use.
168....	367.0	361	6.0	" " " "
157.....	362.0	371	9.0	Superheaters in use.
162.....	364 5	375	10 5	" " "
162.....	364.5	373	8.5	" " "

The temperature in the bottom bend connected to the small tubes in the heating space was measured with a mercury thermometer, and was found as high as 620° F. A considerable part of this heat is, however, given up to the water in the steam drum before the superheated steam passes away by the stop-valve. Mr. Patchell finds that for a period of about one hour during the time of maximum load he can get 50 per cent. more power out of the boilers fitted with this type of superheater than from those which are not yet fitted. We may add that the steam-pipes from the boilers to the engines are thoroughly well coated with fossil meal. Bye passes are now arranged so that the pipes can be filled with steam and so heated up before the main valves are opened. The condensed steam is collected by means of Royle's & McDougall traps, and a Willans steam separator is in use for each of the Willans engines.

The actual economy in coal consumption effected by using two superheaters only in a range of seven boilers is 5 per cent. over a period of 12 months. We are informed that two more superheaters of the same type are now on order, and that all the boilers will be eventually supplied with them. It will be seen that the superheating is not excessive, and can have no deleterious effect upon the lubrication of the cylinders or upon the gland packings. The temperature in no case rises to 400° F., even near the boiler, and there is, of course, a loss of heat in travelling to the engines.—*Engineering.*

LINK GRINDING MACHINE, GRAND TRUNK RAILWAY.

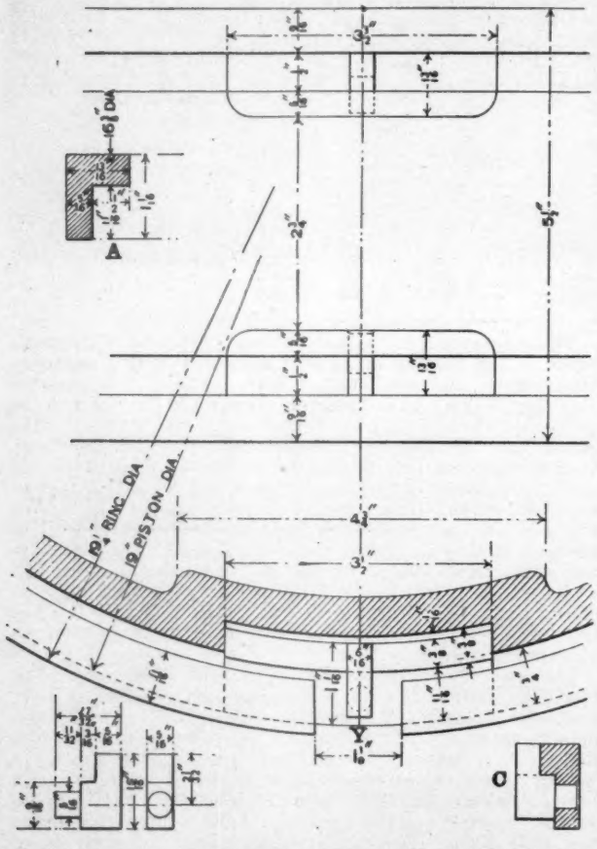
THE half-tone engravings on the opposite page are reproductions of photographs of a link grinding machine that has recently been designed by Mr. William Aird, the foreman of the fitting and turning shop of the Grand Trunk Railway at Montreal, and built for use at that place. In its essential features it consists of a balanced, adjustable, radial arm for carrying the link or link block to be ground, that is given a vertical vibratory motion by means of a crank and connecting-rod, an emery wheel and a blower for removing the dust.

The radial arm is balanced and can be set to any desired radius and any length of stroke in the vertical plane equal to

the length to be ground. This arm makes about six strokes per minute. The emery wheel is also given a horizontal traverse, making about the same number of vibrations as the arm. The counterweight for the arm is suspended from above, and rises and falls in the cylindrical casing shown at the right-hand side of the rear view. The traversing of the emery wheel is accomplished by means of a pair of gimbal connections that appear on the front view. The emery dust and particles that are ground off from the hardened links and blocks are removed by an exhaust fan placed on the floor at the back of the machine. As will be seen from the engravings, the machine is so substantially built and is so rigid in all of its parts that the work is held accurately in position, and the officers claim that the results are as near perfection as can possibly be attained, both as regards the accuracy of the radius of the links and the fit of the blocks.

CYLINDER FOR CLASS P LOCOMOTIVE, PENNSYLVANIA RAILROAD.

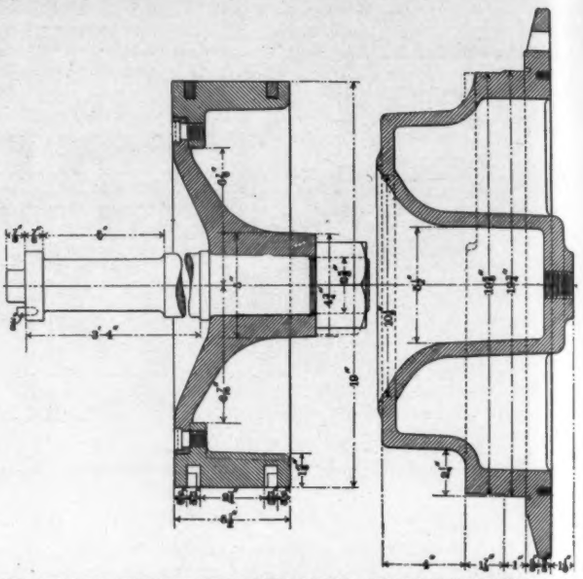
THE cylinders of the new Class P locomotive of the Pennsylvania Railroad contain some interesting features and novelties. An attempt has been successfully made to design the cylinder so that radiation shall be avoided as much as possible, that the weight of the piston shall be greatly reduced, and that the clearance shall be at a minimum. The principal en-



PISTON PACKING, CLASS P LOCOMOTIVE, PENNSYLVANIA R. R.

graving shows the plan, cross, and longitudinal sections of the cylinder. In order to prevent radiation, all the hollow spaces contiguous to the steam and exhaust-pipes are filled with asbestos, thus maintaining the temperature of the metal as uniform as possible. In other details the cylinder differs merely in dimensions from the regular Pennsylvania patterns.

The diameter of the cylinders is 19 in., and the stroke 24 in. The construction of the piston and the front cylinder-head is clearly shown on an enlarged scale by the engraving of these details. The head sets into the counterbore, so that when the cranks are upon the forward centres there is a clearance of $\frac{1}{8}$ in. between the piston and the head. The former is dished and the latter projecting inward, so that approximately the same clearance is maintained across the whole diameter. The piston-rod has a taper of $\frac{1}{4}$ in. in its seat in the piston, and is so fitted as to be forced home with a pressure not exceeding 8 tons. It is further secured by a nut screwed on with eight threads to the inch, with the projecting end of the piston-rod riveted over. This nut is also prevented from turning by a $\frac{3}{8}$-in. pin, which is driven in at the bottom, and is directly in line with the joint of the piston-ring, so that the break in the joint block lies at the bottom of the cylinder. The piston rings are of the simplest character, as shown by the detail engravings. There are two split rings $\frac{11}{16}$-in. deep with wearing surfaces $\frac{1}{4}$ in. wide, and split with a square



PISTON AND FRONT CYLINDER HEAD, CLASS P LOCOMOTIVE, PENNSYLVANIA RAILROAD.

opening $1\frac{1}{8}$ in. wide. At the bottom this opening is closed by a solid L-shaped block $1\frac{1}{16}$ in. high, and holding a stop to prevent the split ring from turning. The outside of the piston is turned to a diameter of 19 in., thus exactly fitting the cylinder, while the split rings are turned to $19\frac{1}{4}$ in. diameter and are sprung into the grooves. The packing is inexpensive, and when compared with the complicated steam packing with its numerous pieces that was used on many roads a few years ago, it shows that simplicity and effectiveness frequently go hand in hand.

FOREIGN NAVAL NOTES.

Another Torpedo-boat Record Speed.—Messrs. Thornycroft & Co. have again broken the speed record for steam vessels with the fourth of the torpedo destroyers, the *Boxer*, which they have just completed for the British Government. As compared with previous accomplishments, the gain is not very great, amounting to barely one-tenth of a knot, but having regard to the fact that the speed of steamships is closely approaching its ultimate limits, and the enormous efforts that are required to obtain even this fractional increase of speed, the record is worth reporting. The *Boxer*, which may be taken to represent the highest type of the torpedo-boat builder's art, has a length of 201 ft. 6 in., and a beam of 19 ft. In the course of an hour's trial, tested by six runs on the measured mile, three with and three against the tide, with a full load of 30 tons and a load draft of water of 7 ft. 2 in., the mean speed attained was 29.314 knots, equal to 33.5 statute miles per hour.

The *Ardent*, which was the predecessor of the present boat and the third of the series, made a speed of 29.182 knots, the engines making 407 revolutions, and developing nearly 5,000 I.H.P.—*Practical Engineer*.

The "Georgi Pobiedonostzeff."—The *Fremdenblatt* gives the following particulars of this new Russian ironclad, the construction of which was begun on August 12, 1889. It has steel armor from 8 in. to 16 in. thick on the sides, while the casemates are protected by 12 in., and the traverses by 9-in. to 10-in. plates. The total length of the ship, including the ram, is about 340 ft. It is 69 ft. broad, and 26 ft. 7 in. deep, with a displacement of 10,280 tons. It is supplied with two engines constructed in England, which will develop 10,600 H.P. under ordinary pressure, and 16,000 H.P. under forced

draft. The new man-of-war is armed with six 12-in. and seven 6-in. guns, as well as 14 quick-firing guns of English manufacture.

Naval Lessons from the War.—A correspondent who signs himself "Navalis" writes to the London *Times* that

"Accounts are pouring in from Chinese, Japanese and neutral sources as to the behavior of ships, armaments, and men in naval action under modern circumstances. The following deductions seem to be fairly substantiated:

"Contrary to prophecy, large guns were not disabled through being dented or perforated by small projectiles propelled at high velocity.

"The unarmored ends of the two Chinese battleships remained intact after Yalu, and the vessels came out of action in a seaworthy condition as far as the structure of the hulls was concerned.

"Torpedoes were ineffective in an open sea action. Well-handled torpedo-boats, although losing some of their numbers, were effective against a fleet debarred from manœuvring.

"Japanese torpedo-boats were fired on, and driven from their objective by friendly warships, during an early and abortive attempt to enter the harbor of Wei-hai-wei.

"A flotilla of 14 torpedo-boats in the open sea was annihilated, with a solitary exception, by a small number of moderate-speed cruisers.

"The burst of one well-placed 12-in. shell disabled the shielded big gun of a protected cruiser and drove her out of action.

"The engines of the surviving ships of either fleet were intact, although fire was concentrated on the centres of the vessels.

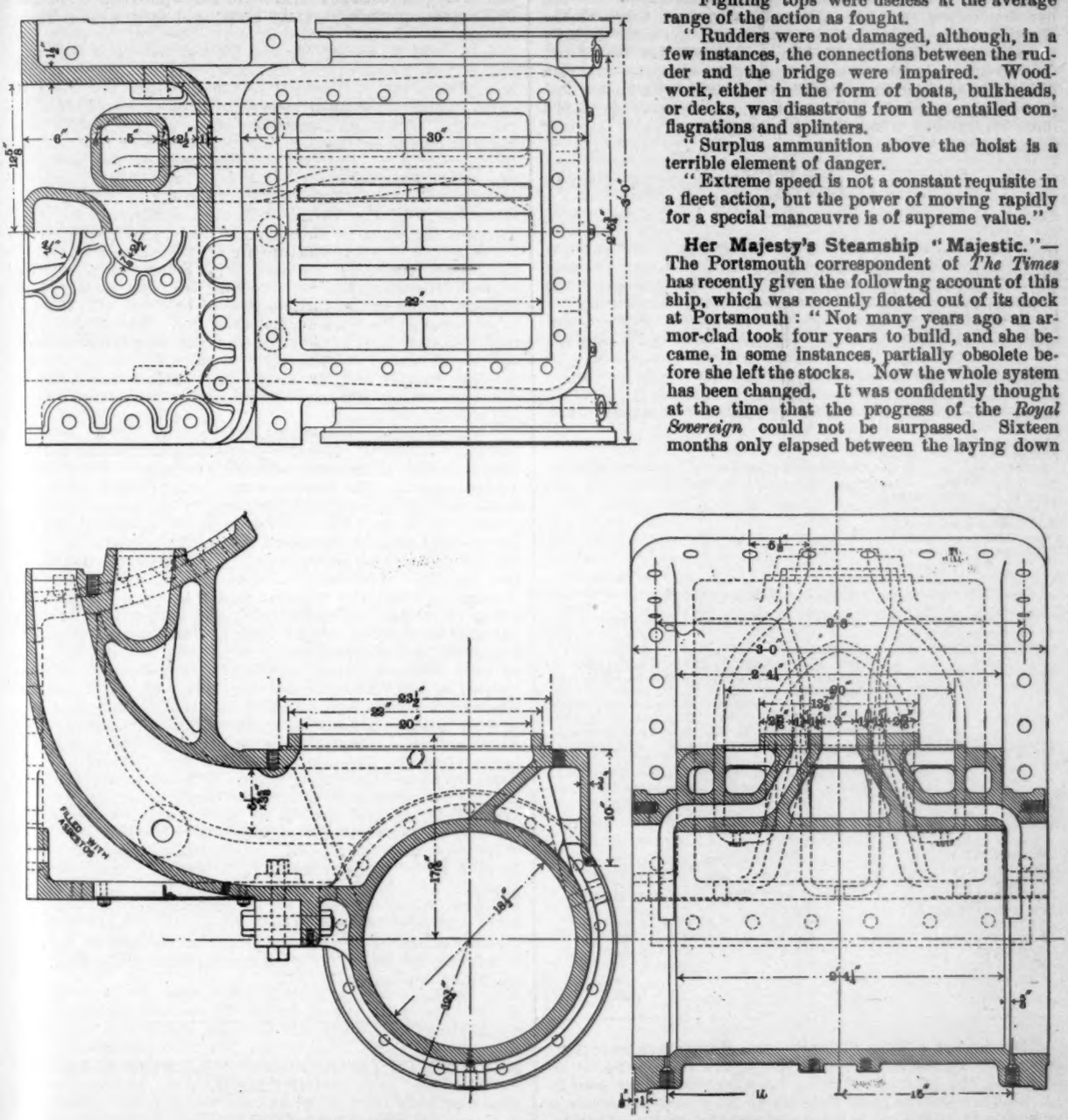
"Fighting tops were useless at the average range of the action as fought.

"Rudders were not damaged, although, in a few instances, the connections between the rudder and the bridge were impaired. Woodwork, either in the form of boats, bulkheads, or decks, was disastrous from the entailed conflagrations and splinters.

"Surplus ammunition above the hoist is a terrible element of danger.

"Extreme speed is not a constant requisite in a fleet action, but the power of moving rapidly for a special manœuvre is of supreme value."

Her Majesty's Steamship "Majestic."—The Portsmouth correspondent of *The Times* has recently given the following account of this ship, which was recently floated out of its dock at Portsmouth: "Not many years ago an armor-clad took four years to build, and she became, in some instances, partially obsolete before she left the stocks. Now the whole system has been changed. It was confidently thought at the time that the progress of the *Royal Sovereign* could not be surpassed. Sixteen months only elapsed between the laying down of the keel plate and the launch, and the work remaining to be completed, which naval experts stated could not be carried out in less than 15 months, was really accomplished in six. As a matter of fact, the 7,250 tons of the *Royal Sovereign*, in consequence of the large amount of armor that was fitted while in dock, represented the greatest weight ever put off the blocks up to the present moment. But the record of that battle-ship was eclipsed by that of the *Magnificent*, at Chatham, which was built in a twelvemonth, and took the water after having had 6,100 tons of material worked into her structure. The exceptional, feat, however, which has been performed in the construction of the *Majestic* is one of which the Portsmouth Dockyard authorities are laudably proud, because, not only does it transcend the Chatham achievement, but it constitutes an unprecedented exploit in



CYLINDER FOR CLASS P LOCOMOTIVE, PENNSYLVANIA RAILROAD.

armored ship-building. She was laid down in No. 13 dock on February 5, 1894, and has been floated out after an interval of five days less than a year with a displacement of 7,300 tons. It will thus be seen that, while she was a shorter period on the blocks, her launching weight was greater than that of the Chatham ship, and that she is, in fact, the most advanced of the vessels building under the Spencer programme.

"The *Majestic* is a sister ship to the *Magnificent*, launched at Chatham. The following comparative statement between her dimensions, weights, and armaments and those of the *Royal Sovereign*, which was floated out of the same dock by the Queen on February 26, 1891, will enable the reader not only to form a judgment as to her general characteristics as a fighting ship of the first class, but to perceive at a glance how it has been possible to build a larger, and in many respects a more formidable, armor-clad without very seriously increasing her displacement:

	Royal Sovereign.	*Majestic.*
Length	380 ft.	390 ft.
Breadth	75 ft.	75 ft.
Draft (mean)	27 ft. 6 in.	27 ft. 6 in.
" (moulded)	44 ft. 5¾ in.	45 ft. 3 in.
Displacement	14,150 tons.	14,900 tons.
I.H.P. (forced draft)	13,000	12,000
I.H.P. (natural draft)	10,000	10,000
Speed (forced)	17½ knots.	17¾ knots.
" (natural)	16¾ knots.	16½ knots.
Freeboard, forward	19 ft. 6 in.	25 ft.
" aft	18 ft.	18 ft. 6 in.
" midship	17 ft. 3 in.	17 ft. 9 in.
Length of armor belt	250 ft.	216 ft.
Depth of belt	8 ft. 6 in.	14 ft. 9 in.
Thickness of belt	18 in., 16 in., 14 in.	9 in.
Thickness of armor bulkheads	16 in. and 14 in.	14 in. to 12 in.
No. of casemates	4	12
Length of side armor above belt	141 ft.	nil.
Thickness of side armor above belt	4 in.	nil.
Thickness of casemates	6 in.	6 in.
" " armor screens	3 in.	nil.
" " belt-deck	3 in.	4 in. on slopes, 3 in. on flats amidships to 2½ in. at ends.
" " barbettes	17 in., 11 in., 6 in.	14 in. and 7 in.
" " conning tower	14 in.	14 in.
" " director tower	3 in.	3 in.
	Four 67-ton guns in barbettes, six 6 in. Q.-F. guns on upper deck, four in casemates on main deck, and 19 small Q.-F. guns.	Four 50-ton guns in barbettes, eight 6-in. Q.-F. guns in casemates on upper deck, four 6-in. Q.-F. guns on main-deck in casemates, and 28 small Q.-F. guns.
	Five above-water torpedo tubes, one in stern, and four on broadside.	One above-water tube in stern and four submerged tubes.
Weights in tons.		
Steel in hull	3,487	4,340
Wood decks, etc	590	570
Backing	140	160
Fittings	800	850
Hull, complete	9,650	10,180
Protective material	1,198	1,410
Armor	3,435	2,850
Equipment	530	600
Armament	1,410	1,500
Machinery	1,100	1,300
Coal, normal	900	900
" full	1,400	1,850

"Besides her additional length, the *Majestic* has important superiority in the auxiliary armament; in the protection of her guns, the casemates having been increased from four to 12, whereby the complete isolation of the gun detachments is secured; in depth of belt; and in coal-carrying capacity, which has been enlarged from 1,400 tons in the *Royal Sovereign* to 1,850 tons, in order to enable her to operate on an enemy's frontier or to steam long distances. Her total weight of protective material is also greater. Strong armored shields are fitted to the turntables and revolve with the guns, an advantage not hitherto possessed by battle-ships of similar dimensions. A saving of weight has been effected in the barbette armament, which is composed of four 50-ton 12-in. guns, which, Sir H. W. White has observed, had they been available in 1889, would probably have been preferred to the 67-ton ordnance. The new guns have a length of 35 calibre, and would have been made even longer had not the difficulties suggested by the ship constructors been considered to outweigh the advantages gained by the extra length from a gunnery point of view. They are capable of discharging a projectile at intervals of less than 1½ minute, are understood to be superior to the heavier types in penetration, and in consequence of their comparatively small weight have enabled the mountings and fittings to be proportionately reduced in size. The arrangements are such that the guns can be loaded and worked from any position by manual appliances, but without dispensing with the advantages obtainable from hydraulic power and fixed stations. An important economy in weight has been effected here; but unquestionably the most appreciable saving has been gained in the armored protection. The belt on the sides, though increased in depth, has been considerably reduced in length. This difference, however, is more than compensated for by the circular form of the armor bulkheads at the ends, which extend for some distance forward and aft and protect the foundations of the barbettes, and are a decided improvement upon the straight bulkheads of the *Royal Sovereign*. A sudden descent has been ventured from a *maximum* thickness of 18 in. in the vertical armor to a uniform thickness of 9 in. But this startling decrease has been justified by the blending of the turtle-back protective decks of the cruisers with the citadel armor of the battle-ships, and by the introduction of Harveyized solid steel armor, which greatly increases the power of the plates to resist penetration. Over 3,000 tons of this manufacture are distributed throughout the ship, fully protecting the machinery, guns, magazines, and crews. The spandrels produced between the sides and the rounded slopes of the turtle-deck will be filled with coal as a supplementary defence against shell fire. The *Majestic* will carry a complement of 18 boats, of which four are steamboats capable of acting independently of the ship for purposes of torpedo attack; and six search-light projectors worked by three dynamos of 600 ampères each. Her crew will consist of 757 officers and men.

"The propelling machinery, designed by Mr. A. Blechynden and built by the Naval Construction & Armaments Company, consists of two sets of triple expansion vertical direct-acting engines. The cylinders are: high-pressure, 40 in.; intermediate, 59 in.; and low-pressure, 88 in. diameter, having a stroke of 51 in. The valves are of the piston description for the high-pressure cylinders, and double-ported slide-valves for the others, and are actuated by the ordinary double-bar link motion. The back columns are cast of the inverted Y shape, securely tied together at the top by a wrought-steel plate, and form the piston-rod guide supports. The front columns are made of forged steel, and are strongly braced by horizontal and diagonal stays; while the bottom frames are of cast steel connected together by cast-steel girders and secured to the frames of the ship. The main and auxiliary condensers are formed of brass throughout, and possess a cooling surface of 13,500 sq. ft. and 1,800 sq. ft. respectively. There are also in the engine-rooms two main-feed pumps, two evaporators and distillers, four bilge and fire engines, two auxiliary air and circulating pumps, four powerful centrifugal pumps, one drain-tank pump, two ventilating fans, two reversing engines, and a brace of turning engines. In each of the four separate boiler compartments into which the ship is divided are two single-ended cylindrical return-tube boilers, 16 ft. 4 in. in diameter by 10 ft. 3 in. long. Each boiler is provided with four corrugated furnaces fitted with a couple of combustion chambers. The boiler-rooms are equipped with auxiliary feed-pumps and forced-draft fans. Supplementary machinery rooms are placed at the sides of the ship containing dynamos, air compressors, ventilating fans, and workshop appliances."

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in March,

has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN MARCH.

City of Mexico, March 1.—A special excursion train filled with pilgrims to the shrine of Sacromonte, in Amecameca, was derailed on its return trip to-day. The engineer, an American, was killed.

New York, N. Y, March 1.—The Washington express on the Royal Blue Line, on the Central Railroad of New Jersey, ran into a wrecked coal train at Bayonne this evening. Engineer William Thompson and Assistant Fireman Winfield Holland were killed. Fireman H. Orell suffered contusions about the body and head, besides having one leg broken.

Mobile, Ala., March 1.—William Lewis, an engineer on the Louisville & Nashville Railroad, was instantly killed to-day by the breaking of a side-rod on his engine.

Birmingham, Ala., March 3.—The boiler of a locomotive on the Central Railroad of Georgia exploded near Weems this morning. Engineer F. A. McGuire and Fireman William Reeves were killed.

Macon, Ga., March 5.—A southbound freight on the Western system of the Southern Railroad left the track just this side of Hilton this morning. The engine turned over on its side, and the engineer and fireman were hurt.

Dickinson, Tex., March 7.—A passenger train on the International & Great Northern Railway ran into an open switch at this point this morning. The engine turned completely over and pinned the fireman beneath it, where he was literally cooked alive by the escaping steam. The engineer was also badly injured.

Poughkeepsie, N. Y., March 7.—In a collision on the Bridge Road this morning at North Clinton Street between a special and a freight train, Engineer Robinson and Fireman Sisson were injured internally.

Newport, Vt., March 8.—A mail train on the Boston & Maine Railroad ran into a boulder at Smith's Mills, P. Q., this morning. The engine turned over, and Engineer F. J. Rooney and Fireman L. A. Emerson were confined in the cab and so terribly scalded that they died from the effects thereof in a few hours.

Augusta, Ga., March 9.—An engine hauling a freight train on the Central Railroad of Georgia broke away from the train at Barnett this morning. Walker Hackney, the fireman, who was just stepping upon the engine, was thrown down and run over by the entire train. He was instantly killed.

Altoona, Pa., March 9.—The boiler of an express engine attached to the Pacific Express exploded at Cove Station this morning. Engineer James Funk was killed and the fireman was badly injured.

Cumberland, Md., March 10.—A freight train on the Pittsburgh Division of the Baltimore & Ohio Railroad ran into a large rock that had fallen on the track near West Newton this evening. Engineer John Hughes was very severely injured, having his skull crushed and an arm broken, and it will be impossible for him to recover. The fireman was also more or less injured.

Poughkeepsie, N. Y., March 12.—Edward Hill, an engineer on the New York & New England Railroad, was killed while coupling his engine to a train at Glenham to-day. The fireman started the engine, and Hill was knocked down and run over.

Pittsburgh, Pa., March 13.—A shifting engine with its train was derailed at the foot of Locust Street, Allegheny, on the Pittsburgh & Western Railroad this afternoon. The engine turned completely over, and the fireman, Miller Zimmerman, was caught in the wreck and instantly killed.

Kingman, Ariz., March 13.—A freight train on the Atlantic & Pacific Railway was wrecked in Truxon Cañon near here to-night. Engineer Sullivan was instantly killed.

Oakland, Cal., March 15.—H. A. Croze, a fireman on the Southern Pacific Railroad, was thrown from his engine in the yards here to-day and instantly killed beneath the wheels of the tender.

Terre Haute, Ind., March 15.—There was a head-on collision between a switching engine and an express train on the Vandalia Line east of this city this morning. Both engineers were slightly injured.

Austin, Tex., March 17.—A mixed train on the Austin & Northwestern Railroad plunged through a bridge 20 miles from this city this afternoon. Charles Enloe, the engineer, and Tom Lunsford, the fireman, were seriously injured.

Keltys, Tex., March 17.—Charles Chaney, a fireman on the Tyler Southeastern Railway, was struck by a locomotive this morning. He sustained serious injuries, but will recover.

Bristol, Tenn., March 17.—A passenger train on the South Atlantic & Ohio Railroad was ditched on a curve this morning near the Natural Bridge Tunnel. Fireman Ed. Grubbs and Engineer Barton were fatally injured by jumping.

Palestine, Tex., March 18.—A freight train on the International & Great Northern Railroad was wrecked near Oakwoods this morning. The engine overturned, and Engineer E. Miller was slightly injured. The fireman, J. Majors, was hurt internally.

St. Louis, Mo., March 20.—A collision occurred between a freight and a stock train on the Chicago, Burlington & Northern Railroad early this morning near Hinckley, Ill. Fireman Williams was instantly killed and Engineer Spencer fatally injured.

Macon, Ga., March 20.—The south-bound vestibule train on the Southern Railroad was wrecked by spikes having been pulled from the rails near Jackson this morning. Fireman Roberts was badly scalded, and may die. The dispatch adds that this is the fourth wreck that has been caused on this road by malicious parties since March 1.

Cumberland, Md., March 20.—There was a rear-end collision between two freight trains on the Baltimore & Ohio Railroad near Magnolia Station this morning. J. H. Owen, the engineer of the colliding train, had his left foot terribly mangled, and was also injured about the shoulders. The fireman, Louis H. Brinkman, also had his foot smashed.

Dallas, Tex., March 21.—There was a collision between a passenger and a freight train on the Missouri, Kansas & Texas Railroad near Fisher this morning. The engineer of the passenger train was killed outright.

Connellsville, Pa., March 22.—A passenger train on the Baltimore & Ohio Railroad ran into a gravel train at Oakdale today. Engineer William Bradley and Fireman George Hutchinson of the passenger train were seriously injured.

Philadelphia, Pa., March 24.—In a freight wreck near Dillersville, on the Pennsylvania Railroad, Engineer James Hock and Fireman Robert McClain were injured.

Charlottetown, P. E. I., March 24.—A passenger train on the Prince Edward's Island Railroad ran into a cow near Traverse City to-day. Both the engineer and fireman were badly scalded and bruised, but not fatally.

Marysville, Cal., March 30.—A gang of train robbers held up a passenger train on the California Northern Railroad to-night. In the *mêlée* the fireman was wounded by a pistol bullet.

Our report for March, it will be seen, includes 28 accidents, in which 13 engineers and 9 firemen were killed, and 9 engineers and 14 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	2
Broken side-rod	1
Cattle on the track	1
Collisions	7
Coupling cars	1
Defective bridge	1
Derailments	4
Falling from engine	1
Misplaced switch	1
Obstruction on track	2
Run over	1
Struck by engine	1
Train robbers	1
" wreckers	1
Unknown	3
Total	28

PERSONALS.

MR. GALEN B. OWENS has been appointed Supervisor of the Pennsylvania & New York Division of the Lehigh Valley Railroad, *vice* MR. JOHN M. RAHM, resigned. He will have charge of all of the tracks of this division in Pennsylvania.

CAPTAIN JOHN G. MANN has been appointed General Manager of the Mobile & Ohio Railroad. Officers of the transportation, roadway, machinery, and traffic departments, and the Purchasing Agent will report to and receive their orders from him.

MANY of the patrons of THE AMERICAN ENGINEER will doubtless remember Mr. Peter Flint, who for a number of years was a travelling representative of this paper, and who afterward occupied a position on the local staff of the New York *Tribune*. His old friends will be gratified to learn that he is now acting as private secretary for the Hon. William Brookfield, Commissioner of the Department of Public Works

in this city, a position for which his natural ability and the experience gained in his connection with THE AMERICAN ENGINEER eminently qualify him to fill.

MR. A. A. READ, Roadmaster of the Mahanoy Division of the Lehigh Valley Railroad, has been appointed Roadmaster of the Mahanoy, Beaver Meadow, and Hazleton Divisions, *vice* MR. I. O. MANDEVILLE, Roadmaster of the Beaver Meadow and Hazleton Divisions, resigned.

M. T. DAVIDSON, builder of the "Davidson" steam pump, removed his New York office and salesroom on May 1, from the quarters so long occupied at No. 77 Liberty Street to No. 133 same street, where the entire first floor will be occupied. This will provide for an extensive show-room, where a large and interesting exhibit of "Davidson" pumps in various styles and sizes will be made, and will afford every facility for the convenient and expeditious handling of the yearly growing business. Parties interested in high-class pumping machinery for all purposes are cordially invited to look in at the new quarters and examine the line of pumps which will be shown.

PROCEEDINGS OF SOCIETIES.

The British Institution of Naval Architects has awarded the gold medal for last year to Mr. D. W. Taylor, assistant to the Chief Constructor of the United States Navy, for his paper on "Ship-shaped Stream Forms."

Boston Society of Civil Engineers.—At the meeting held on March 20 the Secretary read a communication from a committee on standard gauges for thickness of the American Society of Mechanical Engineers, requesting the co-operation of this Society in the effort to abandon the system of arbitrary gauges, and to secure the adoption of a decimal system giving the actual thicknesses and diameters of the pieces. After a short discussion it was voted to refer the communication to the Board of Government, to report back to the Society what action was desirable.

Master Car-Builders' Convention.—Arrangements have been made by the Standing Committee of the Supply Men's Association for an ample amount of space for those wishing to make exhibit at Alexandria Bay during the June Conventions of the Master Car-Builders' and Master Mechanics' Associations. Mr. Charles W. Crossman, proprietor of the Crossman House, has donated the use of the Pavilion, a building 15 ft. wide by 60 ft. in length, with a veranda 9 ft. in width running entirely around it, in addition to which he will, if found necessary, raise a large tent on the lawn. To insure prompt delivery, consignments should be marked Alexandria Bay, N. Y., *via* Clayton, care of The Crossman House, where they will be received by a special committee stationed on the ground at least a week in advance of the Conventions and transported from and to the wharf free of charge. For space or further information address W. C. Ford, Secretary, 29 Broadway, New York City, N. Y.

The American Railway Association has become a member of the International Railway Congress. This Congress, which is to meet in London on June 26, 1895, includes railway officials from all parts of the world, 36 nations being represented in its membership. Many subjects of great interest will be discussed. The Prince of Wales has consented to preside at the opening ceremonies. The delegates so far chosen to represent the American Railway Association are Mr. H. S. Haines, President of the Association and Vice-President of the Plant System, and Mr. W. F. Allen, Secretary of the Association and Manager of the Official Railway Guide. The Association is entitled to eight delegates, and the names of the other six selected will probably be announced shortly. The following named American railway companies are announced as members of the Congress, and are entitled to send delegates on their own account in addition to the representatives of the Association: The Louisville & Nashville; Pennsylvania; Denver & Rio Grande; New York, New Haven & Hartford; Chesapeake & Ohio; Fitchburg; Richmond, Fredericksburg & Potomac; Arizona & Southeastern; Los Angeles Terminal. The session will be held in the Imperial Institute in Kensington. The last session of the Congress was held at St. Petersburg, Russia, in 1892, and the one before that at Milan, Italy.

Engineers' Club of St. Louis.—At the meeting of March 20 the Secretary reported that a "letter from the American Society of Mechanical Engineers, dated February 21, 1895, to the Engineers' Club, asks us to co-operate with their Society in the matter of recommending a gauge system based on actual thickness and diameters and state it in a decimal system. Your committee are unanimous in the opinion that the old arbitrary gauges now in use are apt to lead to confusion, and the course recommended by the joint committee of the American Society of Mechanical Engineers and the Railway Master Mechanics' Association is the right way out of the difficulty. It is absolutely necessary in mechanics and in business that standards should be plain, easily understood, and of as wide acceptance as possible. Since it is not at present feasible to introduce the French system of measures used all over the Continent of Europe, in our practice, there can be no doubt that giving thicknesses in thousandths of the inch is the best practical method of designation.

"Your committee therefore proposes the following resolution:

"*Resolved*, That the St. Louis Engineers' Club recommends to its members, and urges upon all persons using a gauge system to abandon the use of arbitrary gauges and to give the actual thicknesses and diameters in thousandths of the inch.

"*Resolved*, That the Secretary of the Club be instructed to send copies of this resolution to the secretaries of the other associated societies, requesting them to concur, and to the Secretary of the American Society of Mechanical Engineers."

Professor W. S. Chaplin, Chancellor Washington University, then addressed the Club on the subject of German engineering schools and engineering education in general. He visited Germany in the summer of 1894 and took occasion to make a special study of the technical high schools in Berlin and Hanover. He was first struck with the size and magnificence of the buildings, the idea being that expenditures of this character would impress the people favorably, and tend to make the schools rank favorably in comparison with the older universities. The schools were provided with elaborate collections of models, representing all sorts of machinery. These models, however, were not used by the students, but by the professors only. Chemistry was taught to engineering students by lectures only. No students, except those intending to be chemists, were allowed to handle chemicals. The theses were accompanied by very fine drawings, but it seemed that all the designs and computations were made by the professors, the student simply executing the drawings under the immediate direction of the professors. It was necessary to pass two important examinations, one at the end of two years and the other at the end of four years, at which time the student graduated, and took the State examination. It was necessary to pass the latter if the student expected to follow the profession and find employment.

The professors in the technical high schools were looked down upon by those in the universities. Engineers were considered technical and not scientific men. In a recent discussion among German engineers regarding engineering education, it was considered that a groundwork in theory was absolutely essential, but it was necessary also that the student be taught the application of the theories to every-day problems.

German engineering students put in from 41 to 44 hours per week at school, while 35 hours is considered large in this country. Besides this, it is necessary to do a considerable amount of home work at night.

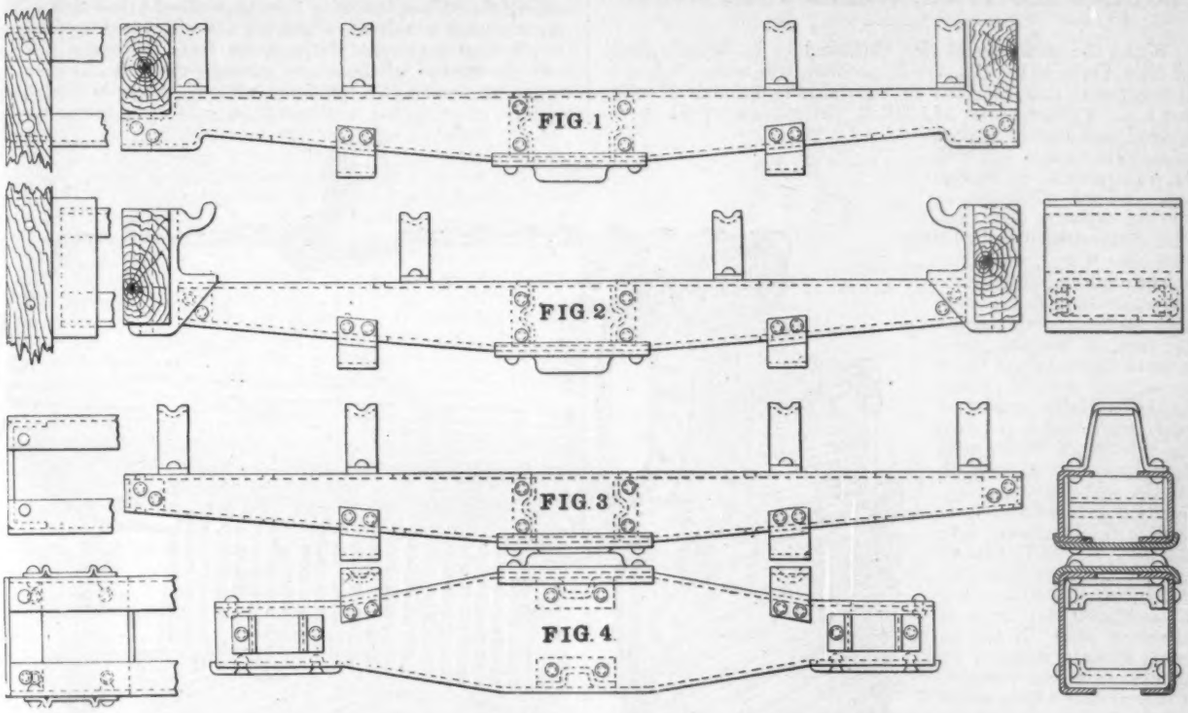
The professor had expected to learn many things of value, but was disappointed. He thought that, on the whole, the training given by American engineering schools was much better suited to American conditions. The technical high schools are entirely distinct from the universities. There are no graduate students. Instruction is simply by lectures, textbooks being used only in mathematics. The standard of entrance is higher than in our schools, and the course of study more thorough, but the field covered is not as wide or as general. The schools are supported almost wholly by government grants, the fees paid forming probably not to exceed 10 per cent. of the income.

AT the meeting of April 3, Professor J. H. Kinealy addressed the Club on the Different Methods of Determining the Heat Value of Fuels. Three plans are in common use: the Analytical, Bertier and Calorimetric. In the first method the calorific power is computed from the chemical constituents of the fuel, they having first been determined by analysis. This process was open to the criticism that the heat value of pure carbon had been shown to vary as much as 3 per cent., depending upon the condition of the carbon. This computation also neglected the sulphur. On the whole, however, he considered this plan the best of the three.

In the second, or Bertier method, the coal was burned in the presence of litharge, the heat value being assumed to be proportioned to the amount of oxygen absorbed from the litharge.

This principle has been shown, however, to be erroneous, but the method nevertheless gives good comparative results.

The apparatus used in the third method is usually the Thompson calorimeter, in which the coal is burned in such a way as to give up its heat to a surrounding body of water of known weight, the rise in temperature of which is noted. This method was shown to have a considerable error, depending upon the temperature of the water used and the heat absorbed by the apparatus itself. Its accuracy depends upon very close reading of thermometers. This method assumed that complete combustion of the coal occurred, which the speaker doubted. This possibility he proposed to investigate further by analyzing the discharge gases.



THE DIAMOND PRESSED-STEEL BOLSTER FOR BODIES AND TRUCKS OF FREIGHT CARS.

Manufactures.

THE DIAMOND PRESSED-STEEL BOLSTER FOR BODIES AND TRUCKS OF FREIGHT CARS.

THE Schoen Manufacturing Company, of Pittsburgh, for some seven years past has been engaged in manufacturing specialties in pressed steel. Among these are truck and body bolsters for freight cars. The causes which led up to their manufacture are stated as follows in one of their circulars:

"Bolsters, as they are commonly used to-day, are composed of wood and iron; and owing to their construction, are subject invariably to the shrinkage of the wood, and the consequent loosening of nuts, and therefore soon disintegrate. The integrity of the structure is entirely dependent upon everything being kept tight, which is next to impossible, the inevitable result being, in a comparatively short time, that the bolsters must be renewed in whole or in part. Every one having charge of the repair of freight cars knows to what extent this is true."

In a report to the Master Car-Builders' Association the Committee on Freight Car Trucks recommend the introduction of steel or wrought-iron bolsters, and say:

"The committee made personal inspection of 61 different styles and makes of freight trucks, largely composed of wood transoms and bolsters, and every truck was more of less defective on account of the parts shrinking, causing loose bolts, and many other parts split, checked, cracked, splintered, worn away, warped, etc., and we therefore recommend that timber not thoroughly seasoned is unfit for car-truck construction to produce economic results, and as builders cannot use seasoned timber, we would recommend the introduction of steel or wrought iron in place of green, unseasoned timber."

To overcome these difficulties the Schoen Manufacturing Company have devised the system of bolsters represented in the engravings herewith. These are made of steel plates pressed into a channel form. Fig. 1 represents a body bolster with the form of ends which are required when side sills are not more than 2 in. deeper than the intermediate sills. A plan view of one end is shown on the left side. Fig. 2 is an elevation of a body bolster showing the style of bracket which is used when the side sills of the car-body are more than 2 in. deeper than the intermediate sills. A plan of the end is shown on the left side, and an end view of the bracket on the right. Fig. 3 represents a form of body bolster which is used when the sills are all of the same depth. A plan of end is shown on the left and a section on line *A B* on the right. Fig. 4 is an elevation of a truck bolster which is raised in the middle, but they are also made straight when required. A plan of the end and a section on *A B* are also shown.

The advantages claimed for pressed-steel bolsters are a reduction of cost of repairs and dead weight, greater mileage and more service of car, thus giving a better riding car, and the bolsters have a scrap value when they are condemned.

THE HOGAN WATER-TUBE BOILER.

THE Hogan Boiler Company, of Middletown, N. Y., which has for some time past been engaged in exploiting and perfecting their boiler, threw open their works on April 9 for the inspection of representatives of the trade press, mechanical engineers, representative manufacturers, and steam-users. About a car-load of persons belonging to these classes availed themselves of the invitation and were present at that time. After partaking of the hospitality of the company at the hotel in Middletown, the visitors were taken in conveyances to the works, where a boiler has been erected and which was subjected to the inspection of visitors and to some tests in firing and evaporation. Owing to the limited time these tests could not be satisfactorily carried out, although every provision had been made for doing so.

The boiler consists of two cylindrical "distribution drums" which are placed longitudinally on each side of the grate, a few feet above it. Another single drum, called a "steam extractor," is placed a considerable distance above the distributing drums, and the upper and lower ones are connected together by tubes bent into suitable forms for that purpose.

The drums and pipes are enclosed in brick-work and have circulating pipes outside.

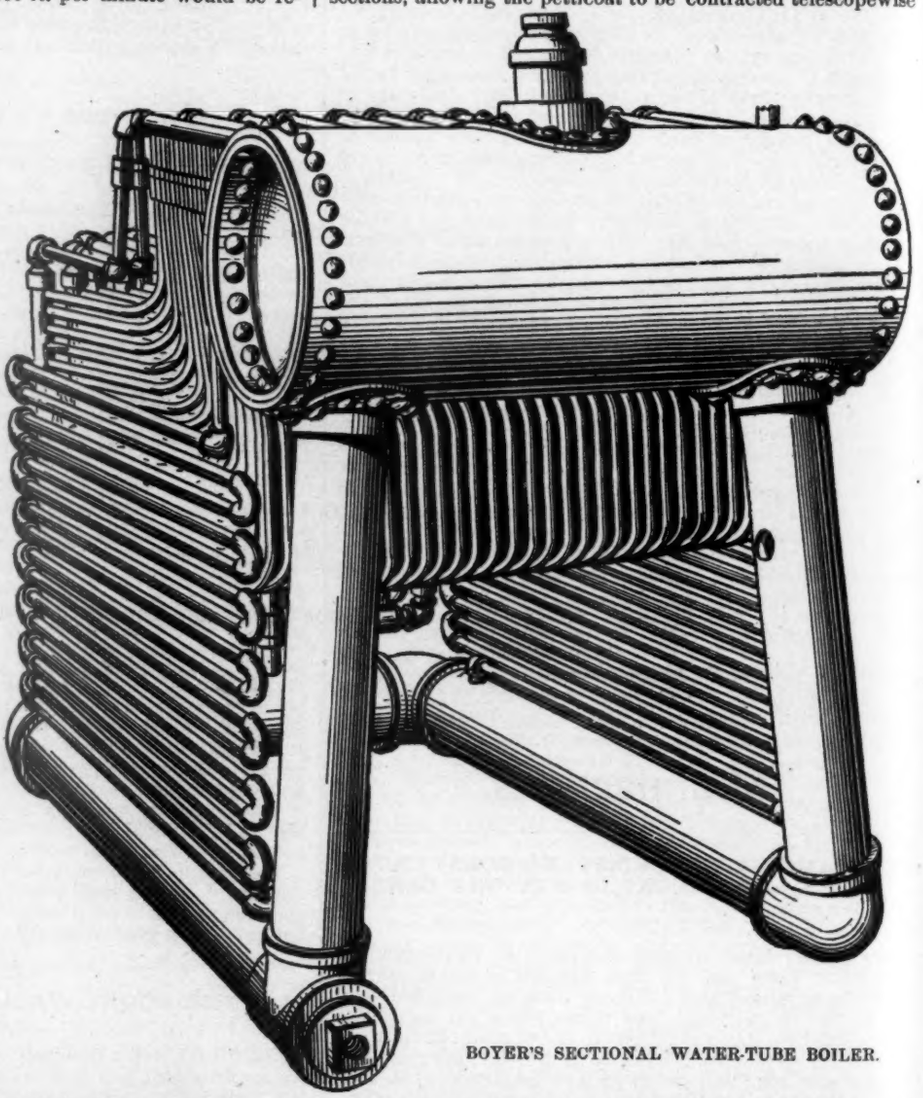
After inspecting the shops and the boiler, which was under steam, and making some partial tests, the company were taken to the asylum near Middletown to see a boiler plant which has been erected there.

The Hogan Company will now put this boiler on the market, feeling confident that it will do all that has been expected of it.

BOYER'S SECTIONAL WATER-TUBE BOILER.

When the steam yacht *Rex*, exhibited by L. Boyer's Sons, of New York, at the Chicago Exposition, was being designed, it was found that, in order to maintain the speed of 31 miles per hour, a piston speed of 1,500 ft. per minute would be required, and that in engines of only 9 in. stroke. The boiler requirements to furnish this amount of steam at 300 lbs. pressure were such that of the many pipe boiler builders there was only one firm who would guarantee to accomplish this, and their boiler would weigh 9½ tons, a weight sufficient to prevent great speed by so small a boat. Chief Engineer Kaine was thus confronted with a problem the solution of which once more demonstrated the truth of the old saying, "Necessity is the mother of invention." The boiler thus designed weighed only 2⅛ tons; is made of wrought-iron tubes screwed together in sections and without any dead ends. It has no joints directly attacked by the heat from the furnace. It is provided with a steam drum of best steel plates double riveted, which is entirely removed from the heat of the furnace. There is a sufficient water space, a large combustion chamber with ample and very efficient heating surface. The casing is of sheet iron lined on the inside with the best non-heat-conducting material, and is easily removed for repairs. This boiler is exceedingly simple in construction. There is an arrangement whereby access may be had to any part of the boiler with the greatest ease and with the least delay, for the purpose of cleaning or repairing, or for the removal of any one or more of the parts and the substitution of other duplicate portions. This boiler is so designed that, while provided with ample water and steam space, it is capable of generating very large volumes of steam with great rapidity, and occupies an extremely small floor area and cubic space. It has a low centre of gravity, a short, rapid and perfect circulation. This boiler is especially adapted to marine engines of very high speed, to be used upon boats of light draft, when the utmost economy of space and weight, with ample strength, entire safety, a greatly amplified heating surface, a capacity of generating large volumes of steam with the utmost rapidity and uniformity, and an economical consumption of fuel are all essential.

The *Rex* recently cruised from Albany, N. Y., to New York City, a distance of 144 miles, on 1,000 lbs. of coal, thus showing the unparalleled economy of this boiler. This simple and perfect steam generator is a comfort to the engineer, can be taken care of by any one, and can be repaired at any time or place, its fittings being of standard sizes.



BOYER'S SECTIONAL WATER-TUBE BOILER.

Recent Patents.

MOORE'S VERTICAL WATER-TUBE BOILER.

Mr. Matthew Robert Moore, of Indianapolis, Ind., has patented the form of boiler shown by fig. 1, which he describes as follows:

"The lower part is a peculiarly shaped drum, *B*, of an inverted bottle form, a central portion, B^2, of less diameter extending down below the grate, while the main portion *B* is held at a considerable height above the fire. The contracted portion of the lower drum is incased by fire-brick *A'*. The mid-height of the boiler is a set of vertical tubes *D D*. The upper part *M* is a drum in which a liberal surface is presented for the disengagement of the steam from the water. I promote the descent of the water through the tubes *D'* near the centre by means of a petticoat rim, *E*, made in horizontal sections, allowing the petticoat to be contracted telescopewise whenever necessary for repairs or cleaning. When extended downward so as to be fully efficient, it protects the central set of tubes from being affected by the large volume of steam generated in the exterior portion of the lower drum. The steam generated there rises through the series of tubes above, and insures an active upward current of steam and water through those tubes, and further steam is generated in these tubes by the circulation of the gaseous products of combustion through the spaces between them. The steam and water thus rising separate in the upper drum and the steam is conveyed away for use. The water descends through the central tubes of the series, which tubes are over the central portion of the bottom. The small quantity of steam generated in these central tubes is carried down by the descending current, and moving outward in the lower portion rises and contributes to the vigor of the strong rising columns in the tubes near the periphery of the series. The non-conducting protec-

tion A' between the central portion of the boiler and the annular furnace which surrounds it protects the fire from being too much cooled along the inner edge and allows all portions of the grate surface to be about equally efficient. The fire-brick also preserves that portion of the boiler from being overheated in any exigency. The annular grate L is slightly inclined inward. A shaking grate is preferred, but this is not material. The annular furnace is fed, cleaned, etc., through doors in the outer casing. A perforated protection of fire-brick, A^3, is extended over the fire at a proper height. At the mid-height of the tubes the masonry wall is extended inward, so that it comes nearly or quite in contact with the outermost tubes. The hot gaseous products of combustion deflected inward thereby are caused to circulate among the tubes. They are afterward led outward and upward around the exterior of the upper drum and finally collected and conveyed away through a central stack at the top.

"A pit a is provided below the boiler to facilitate the removal of the bottom plate B^3 in cleaning or repairing. When a number of my boilers are set together, the pits a may be left open and communicate with a tunnel through which the ashes can be conveniently removed without the annoyance of hauling them out through the fire-room."

The patent is No. 535,115, and is dated March 5, 1895.

MUMFORD'S WATER-TUBE BOILER.

Fig. 2 represents another form of water-tube boiler patented by A. G. Mumford, of Colchester, England.

"This invention," he says, "relates to an improvement in that type of water-tube boilers having a steam collector, A, and two water chambers C and C', the latter each connected to the former by a series of small tubes D and one or more circulating pipes F, and it consists in arranging the said water tubes in groups to form self-contained elements by connecting their ends to two boxes or chambers, which are connected respectively with the steam collector and water chambers by single pipes E fitted with flanged or other suitable joints, the said boxes respectively being arranged side by side to form the top and sides of the fire-box or furnace G, the object being to facilitate the repair of the boiler in case of accident to any of the tubes.

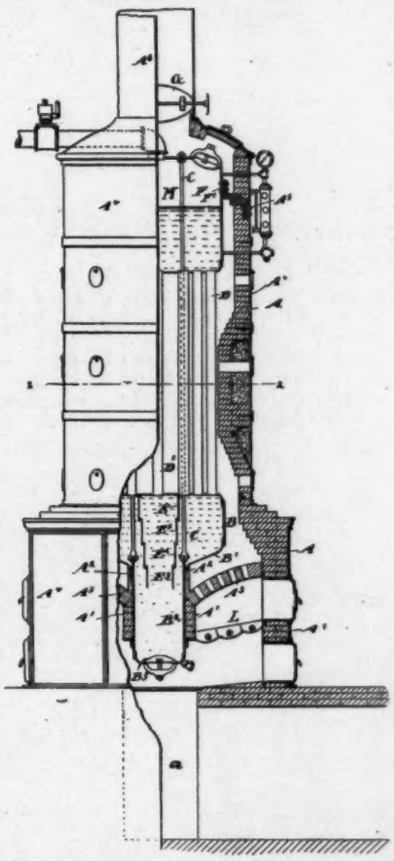


Fig. 1.
MOORE'S VERTICAL WATER-TUBE BOILER.

"Each of the boxes C on each side of the boiler is connected with the adjacent box C' by a group of curved tubes D, the said tubes being of such a curvature that they can readily be withdrawn or inserted through one or other of the said boxes after the removal of the cover thereof. It will thus be seen that one box C, one box C', and one group of tubes D forms a self-contained element.

"The pipes E and E' connecting the boxes C and C' with the steam collector A and water chambers respectively may run into or be connected to the covers of the said boxes, but they are preferably arranged to run into or to be connected to the boxes themselves so as to leave the covers thereof free for removal without breaking the joints e or e'.

"The steam collector or reservoir A is connected with the water chambers B and B by means of one or more circulating pipes F. In a single boiler two such pipes are used, and they are preferably arranged at the front end of the boiler, as shown by fig. 2, but in a double-ended boiler they are preferably arranged between the two parts of the boiler. When two circulating pipes are used, as shown by fig. 2, the two chambers B and B are sometimes connected together at the back end of the boiler by a pipe such as b."

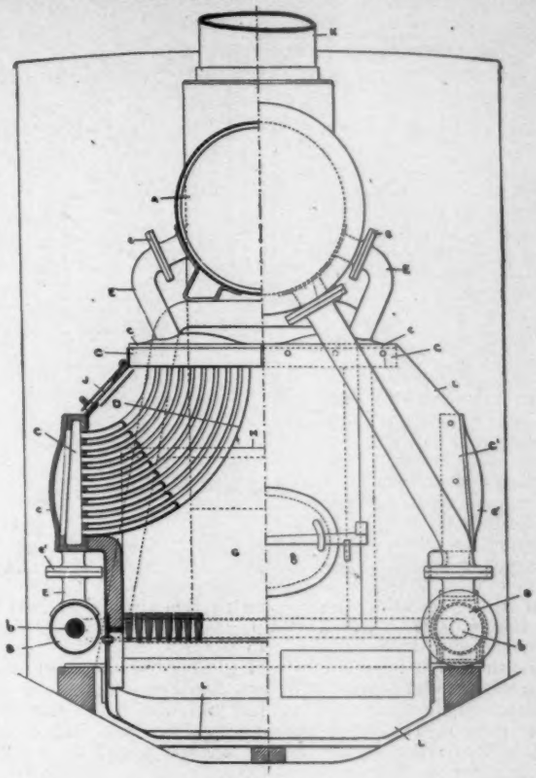


Fig. 2.
MUMFORD'S WATER-TUBE BOILER.

The date of the patent is March 5, 1895, and it is numbered 535,068.

BULLA'S LOCOMOTIVE.

Mr. Melbern B. Bulla, of Yuma, Arizona Territory, has patented the design for locomotive shown by fig. 3. This is a compound engine with two high-pressure cylinders outside of the wheels and frames and two low-pressure cylinders between the frames. In order to get as wide a fire-box as possible he places the frames outside of the wheels. The pistons of the high-pressure cylinders are then connected to cranks C on the ends of the main driving-axle D, as shown in the engraving. The pistons of the low-pressure cylinders are connected to cranks on the main axle, the inside and the outside cranks on each side being placed opposite to each other, so that the pistons balance each other. The chief peculiarity of this plan, though, is the arrangement for dispensing with the use of coupling-rods. To accomplish this end the front driving-wheel E is connected with the corresponding rear drive-wheel by friction wheels L, secured on a transversely extending shaft L^3 mounted to turn in suitable boxes N fitted to slide vertically in suitable bearings arranged in the side frames F of the locomotive.

The lower ends of the bearings N are engaged by springs O, each held in a frame, P, connected at its upper end with the piston-rod Q of the piston in a steam cylinder R arranged on the locomotive, the said cylinder being connected by a steam-pipe, S, with the corresponding steam-chest of the high-pressure cylinder A, so that whenever live steam is admitted to the steam-chest of the high-pressure cylinder, then it also passes through the pipe S into the lower end of the cylinder R to force the piston therein in an upward direction, to lift the frame P and springs O to move the boxes N upward and to cause the friction roller L to move in firm frictional contact with the peripheral surfaces on the front and rear driving-wheels E and K.

When the steam is shut off from the steam-chest of the high-pressure cylinders, by the engineer closing the throttle, then the pressure on the piston in the cylinder R is released and the frame P can slide downward by its own weight, so

as to relieve the pressure on the spring *O* and boxes *N* to permit the friction wheel *L* to move out of frictional contact with the sets of front and rear driving-wheels. Each friction wheel has a diameter about 6 in. greater than the distance between the periphery of the front and rear driving-wheels, and each friction wheel is placed below the centre of the driving-wheels.

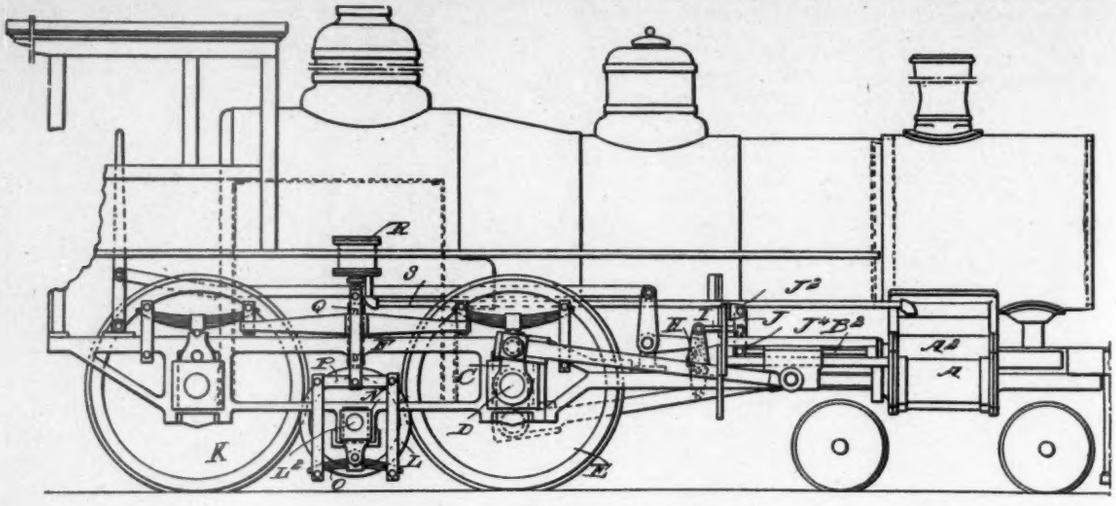


Fig. 3.

BULLA'S LOCOMOTIVE.

It will be seen that by the construction above described the friction wheels *L* are held up against the driving-wheels *E* and *K* with sufficient force to prevent their slipping, and when the steam is shut off from the high-pressure cylinders, then the friction wheels will drop down clear of the driving-wheels and allow the engine to run with diminished friction.

By the construction described no side rods and no pins in the back driving wheels *K* are necessary, and no counterbalancing is required.

The date of the patent is March 12, 1895, and its number is 535,668.

SCHMIDT'S DOUBLE-ACTING STEAM-ENGINE.

The operation of this engine is similar to that of a compound engine with a receiver, but with the difference that one side of the low pressure is constantly under the influence of the low-pressure steam piston, and that the space between that side of the low-pressure piston and the opposite cylinder-cover forms part of the receiver, the capacity of the latter being, therefore, a variable one.

Fig. 4 represents a longitudinal section of the cylinders, steam-chest, and receiver.

The objects of the invention are, first, to provide an engine, which is specially adapted for the use of superheated steam; and, second, to cause in such engine the high-pressure cylinder to be cooled by the low-pressure steam, and the low-pressure cylinder to be heated by the receiver steam.

a is the high-pressure cylinder, within which works the hollow high-pressure piston a^3 of plunger-like configuration. This piston extends into the low-pressure cylinder and carries at its end the low-pressure piston b^3, by which latter the said cylinder is divided into two compartments or chambers b' and b^2. Chamber b^2 extends as a matter of course up into the hollow plunger and constitutes the variable receiver part mentioned. This part is in constant communication with the receiver proper *c* by a port, *d*, while the high-pressure cylinder *a* and the annular chamber b' of the low-pressure cylinder are alternately brought into communication with the receiver proper *c* by the hollow slide-valves *e* and *f*. These valves are made integrally, and are operated simultaneously by one and the same valve-rod *g*.

Supposing the valves be in their highest position, the high-pressure steam entering the engine at *h* will flow into cylinder *a* through the groove around the contracted portion of valve *e* and through the channel *i*. During this time the low-pressure steam contained within the receiver *c* will flow into the annular chamber b' through the passage *l*, acting therein on a piston surface of an area equal to the difference between the working surfaces of the two pistons. As the chamber b^2 is constantly filled with the low-pressure steam, there is consequently a pressure counteracting that of the high-pressure steam, the said counteracting pressure being produced by the influence of the low-pressure steam upon the lower side of the high-pressure piston. During the expansion period the valves *e* and *f* are in their middle position, as shown in the drawing. If thereafter the valves are lowered, the high-pressure cylinder *a* will by means of the passage *i* and the internal opening in the valve *e* come into communication with the receiver proper *c*, while the chamber b' of the low-pressure cylinder communicates through the passage *l* the annular groove in the valve *f* and the outlet *k*, either with the atmosphere or with a condenser. The chambers *a*, receiver *c*, and chamber b^2 are thus filled with steam of equal pressure, and the piston on its return stroke is acted on by a pressure constituted by the influence of the low-pressure steam on a piston surface of a size equal to the difference between the working surfaces of the two pistons.

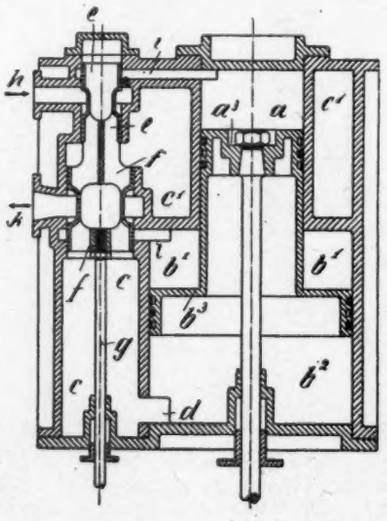


Fig. 4.

SCHMIDT'S DOUBLE-ACTING STEAM-ENGINE.

Besides the chamber b^2 of the low-pressure cylinder, the annular space *c'* around the high-pressure cylinder *a* also forms part of the receiver. Therefore the latter cylinder as well as the small piston is constantly cooled by the low-pressure steam present within said space *c'*, while the low-pressure steam present within chamber b^2 constantly heats the low-pressure cylinder as well as the large piston. By reason of these functions of said spaces, the engine is specially adapted to be driven by superheated steam. There is, then, the further advantage that stuffing-boxes may entirely be dispensed with.

This form of engine is the invention of Mr. Wilhelm Schmidt, of Wilhelmshöhe, Germany. We are not able to say with certainty whether this is the kind of engine—but presume it was—which was tested in connection with the boiler which was illustrated and described in our issues of February and April, and of the performance of which reports are given in the former and also in this number of THE AMERICAN ENGINEER.

The number of Mr. Schmidt's patent is 535,864, and it is dated March 9, 1895.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

SOME EXPERIMENTS ON THE EFFICIENCY OF AIR PROPELLERS.

BY HENRY GOLDMARK.

AIR screws or propellers have long been a favorite form of mechanism in projects for artificial flight, but experimental data, from which the relative efficiency of different types of screws could be determined, have hitherto been almost wholly lacking.

Even in the case of propellers working in the water, though used on so extensive a scale in steam navigation, the mathematical analysis is quite incomplete; so that engine designers are compelled to depend mainly on empirical formulæ and the rule of thumb.

In the case of air screws, which work in a medium subject to great variations in pressure as well as temperature, the theoretical investigation is of course even more difficult. For this reason a series of experiments made during the past year by Professor Georg Wellner, of Brünn, Austria, is of considerable scientific interest apart from any special application to problems in aeronautics.

The following *résumé* of his investigations has been prepared from a paper read by the author before the Austrian Society of Engineers and Architects, and published in their transactions.*

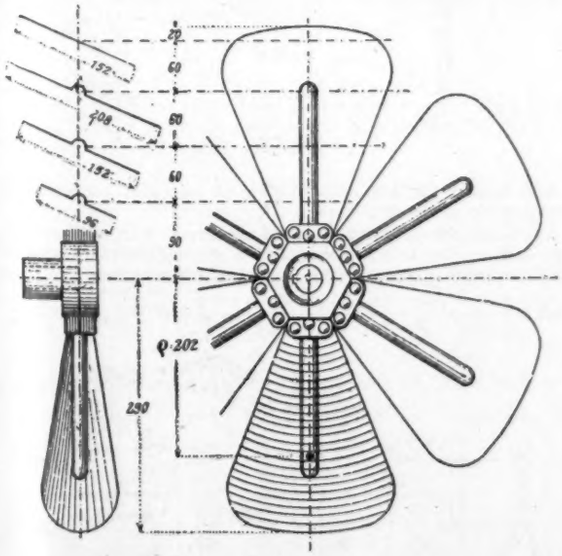


Fig. 1

The task the author had set himself was to determine for some half-dozen different forms of air screws the axial thrust exerted against the air and the amount of power required when the propellers revolve at different rates of speed.

His apparatus consisted of three parts:

1. A Siemens-Halske electric motor rated at ¼ H.P. when making 1,500 revolutions per minute.

2. Air screws of different shapes and sizes, which could be readily attached to the shaft of the motor.

3. Devices for measuring the power absorbed in turning the screws as well as the actual thrust or reaction.

The various forms of propellers used are shown in figs. 1–6. For the purpose of comparing the different forms, the total projected area of the blades on a plane normal to the axis was in each case measured, and the reaction of the air was supposed to be concentrated at a distance from the axis equal to the radius of gyration.

These forms may be briefly described as follows:

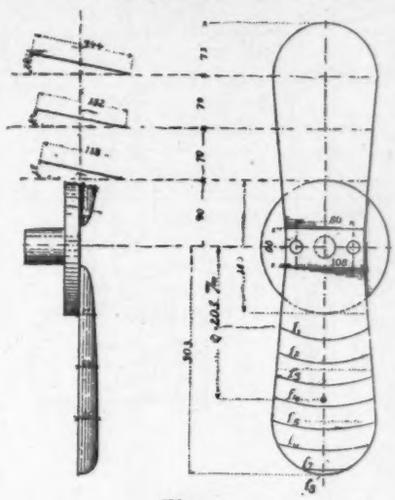


Fig. 2.

Fig. 1.—This is a six-bladed fan wheel built of sheet steel 1 millimetre in thickness. The blades are flat, inclined at 22½° to the normal plane, with a stiffening rib in each blade.

Its outside diameter = .580 metre (22.8 in.).

Its weight = 3.75 kilograms (8¼ lbs.).

The total area of the blades = .2124 square metre (2.286 sq. ft.).

The radius of gyration = .202 metre (7.99 in.).

Fig. 2.—The wheel consists of two small blades made of tinned plate. It weighs .340 kilogram (¾ lb.).

Its outside diameter = .606 metre (23.85 in.).

The blades are planes inclined at 10½°.

The total area of the blades = .05542 square metre (.596 sq. ft.).

The radius of gyration = .203 metre (8 in.).

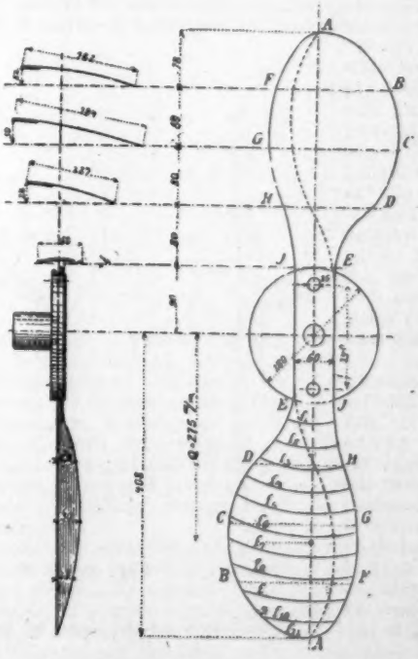


Fig. 3.

Fig. 3 is a spoon-shaped propeller built both with two blades (as shown in the drawing) and also with four. The shape is clearly indicated in the sketch, also the reinforced edges.

With two blades it weighs .70 kilogram (1½ lbs.).

The area of two blades = .085 square metre (.915 sq. ft.).

The outside diameter = .816 metre (32.12 in.).

The radius of gyration = .275 metre (10.83 in.).

* From the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereins.* Vienna, August 17 and 24, 1894.

Fig. 4.—This drawing represents a "shovel-shaped" hollow warped surface, tapering to a point, with constantly decreasing curvature.

Its external diameter = 1.018 metres (40 in.).

Its total weight = .97 kilogram (2⅛ lbs.).

The area of the blades = .1223 square metre (1.316 sq. ft.).

The radius of gyration = .2997 metre (11.8 in.).

Fig. 5 is an S-shaped fan wheel, very slightly concave.

The area of the blades = .3322 square metre (3.57 sq. ft.).

The radius of gyration = .215 metre (8.46 in.).

Finally, fig. 6 shows a screw conforming closely to a true helicoidal surface of constant pitch. The central part is built up of two thicknesses of tinned plate, with stiffening angles. The angle of the blades varies from 9° to 45°, as shown by the cross sections.

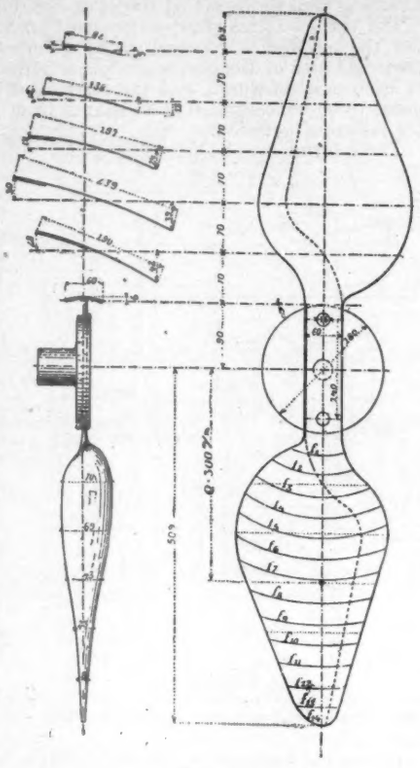


Fig. 4.

The external diameter = .980 metre (38.58 in.).

The total area of the blades = .089 square metre (.958 sq. ft.).

The radius of gyration = .3168 metre (12.47 in.).

The two methods used for measuring the thrust K are shown in figs. 7 and 8.

The *first method* consists in mounting the electric motor with the air screw attached on platform scales. The *upward* reaction produced by the screw when it is rotated can then be directly measured on the scale pan.

The *second* method (fig. 8) is less direct, but probably gives more reliable results than the first, as the action of the screw is not impeded by the proximity of other bodies. In this case the thrust K is held in equilibrium by the force of gravity, so that $K = \frac{s}{k} Q \sin. \varphi$ where Q = total weight of the pendulum, and φ is the observed deflection angle for any given speed.

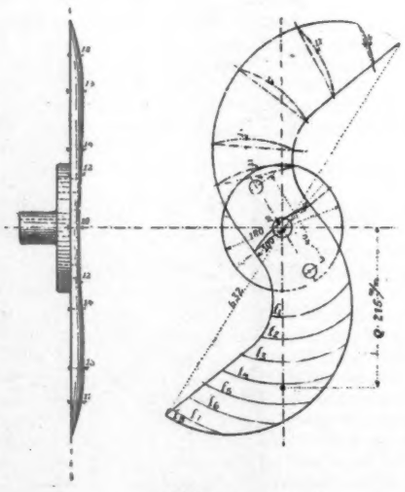


Fig. 5.

The power required to rotate the propellers was determined by electrical measurements. The motor (supported on the platform scales or suspended as a pendulum) was first run "light"—*i.e.*, without attaching a propeller, at speeds varying from 250 to 1,500 revolutions per minute.

Simultaneous observations were taken of the revolutions per minute, the current strength C and the electromotive force E. The resistance of the circuit R had been previously measured.

This gives us directly:

The total work done per second = $E\,C$ in watts.

The energy dissipated as heat = $R\,C^2$.

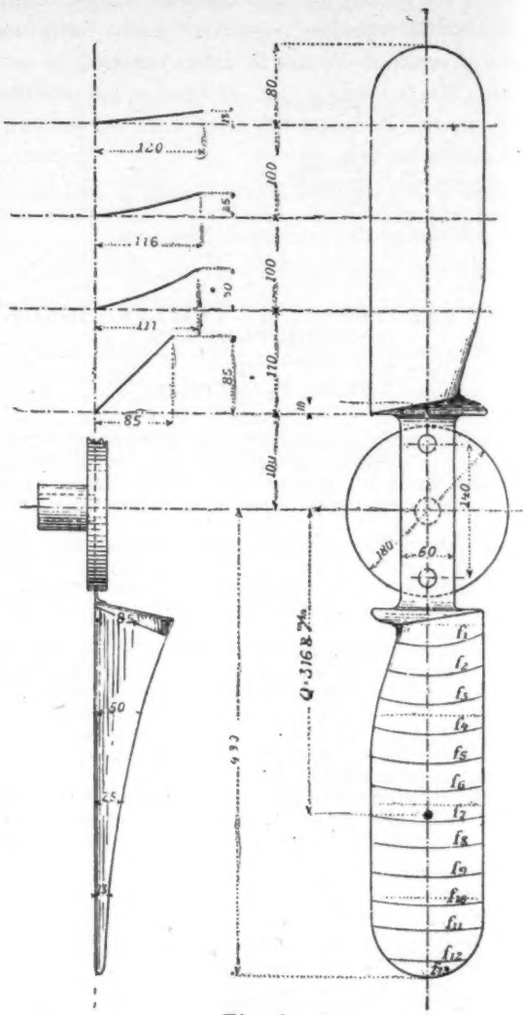


Fig. 6.

And finally, the *net amount of work expended per second in running the motor* = $E\,C - R\,C^2$.

After this the different forms of air screws were successively attached to the motor shaft, and a corresponding series of measurements made. From these last observations the *gross* amount of power required to run the motors, with propellers attached, was calculated by the formulæ given above.

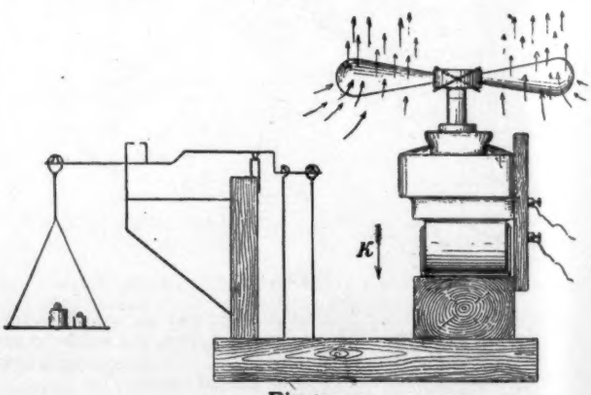


Fig 7.

The difference between these last values and the figures previously obtained when running the motors "light" at the same

speeds gave the net H.P. required for the propellers alone. At the same time the thrust K was measured for the same rates of speed. From these data a comparison of the efficiencies of different types was readily made.

A summary of the results obtained is given in the following table:

In this table

K = axial thrust in kilograms,

F = total area of propeller blades in square metres,

and

U = energy absorbed per second in metre kilograms,

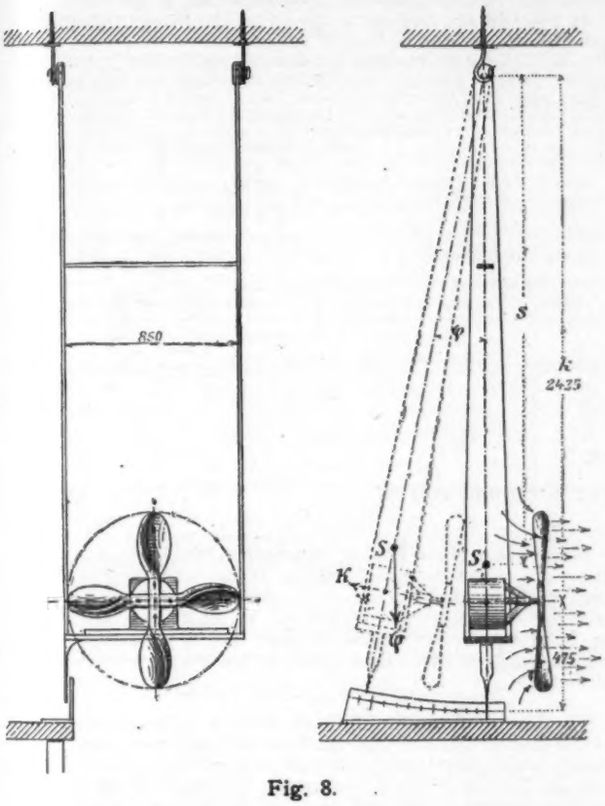


Fig. 8.

and the velocities given refer to the centre of gyration of each blade, or that point whose distance from the axis of revolution is equal to the radius of gyration.

TABLE I.

Velocity per Sec. of the Centre of Gyration.	Values of $\frac{K}{F}$, *i.e.*, Axial Thrust in Kilograms Produced by 1 Square Metre of Blade Surface.				Values of $\frac{U}{K}$, *i.e.*, Power in Meter Kilograms per Second Required to Produce 1 Kilogram of Axial Thrust.			
	5 m.	10 m.	15 m.	20 m.	5 m.	10 m.	15 m.	20 m.
Type 1.....	0.38	1.38	3.43	5.60	7.0	8.4	11.8	15.8
Type 2.....	0.33	1.32	3.01	5.18	4.5	6.0	7.1	8.2
Type 3—2 blades.....	0.49	1.90	4.29	7.40	5.2	5.4	5.6	7.3
Type 3—4 blades.....	0.36	1.25	3.06	5.61	3.3	3.8	5.6	6.6
Type 4.....	1.08	4.25	8.26	14.80	2.5	3.9	5.6	6.5
Type 5.....	0.04	0.15	0.34	0.60	15.0	25.0	38.0	60 0
Type 6.....	1.11	4.20	7.82	10.30	1.5	2.5	3.9	5.0

This table enables us to calculate the amount of thrust obtainable from propellers of different sizes by the expenditure of 1 H.P., and to see at a glance which are the most efficient shapes. We are also able to discard certain types tested as not suited to our purpose.

In the first place, we find that screws with only two blades give better results than those with four or six, and that narrow blades are more efficient proportionally than broad ones. This is probably due to the fact that there is less interference in the air currents from the several blades.

The outline in plan or shape of the blades is of no special importance, but the convex cutting edges probably tend to reduce air friction.

The high efficiencies obtained with types Nos. 3, 4 and 6 as compared with Nos. 1 and 2 show the great advantages of curved over flat blades. This is also clearly shown in the case of the S-shaped surface No. 5, which has an angle of inclination equal to zero, and is only slightly concave and still exerts an appreciable thrust, though of course not a large one. For this reason Professor Wellner recommends strongly the use of slightly hollowed blades with a versed sine of one-twelfth to one-twentieth of the chord length.

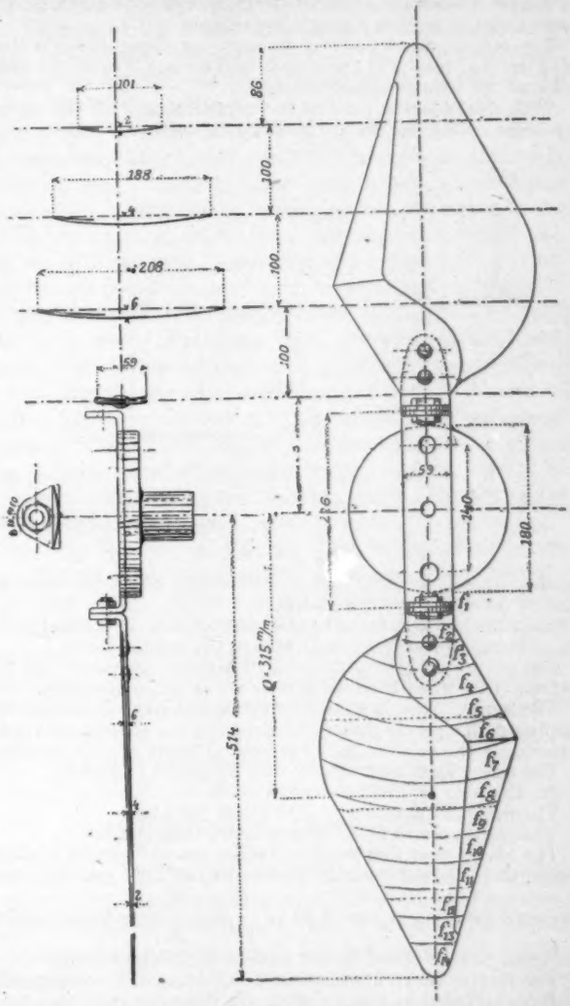


Fig. 9.

For aeronautical purposes screw propellers may be used horizontally to propel the car forward, or they may be mounted on a vertical shaft so that they will tend to lift the load. In the first case the reaction against the air K represents the propelling force, and in the second the direct "lift."

It is quite clear that the most powerful screw is the one which gives the greatest thrust for the smallest expenditure of work on the part of the prime mover, a consideration of even more than the ordinary importance in the case of machinery used in air ships.

All in all, the shovel-shaped propeller (fig. 4) and the true screw surface (fig. 6) give by far the best results at all speeds, as is seen at once by comparing the coefficients in the table. For example: For a velocity (of the centre of gyration of the blade) of 10 metres per second, type No. 4 requires only 3.9 metre kilograms per second in order to produce a thrust of 1 kilogram. Hence 1 H. P. (or 75 metre kilograms per second) would produce a thrust of $\frac{75}{3.9} = 19.23$ kilograms. The required blade area may be computed from the corresponding coefficients in the first half of the table.

In this case $F = \frac{19.23}{4.5}$, giving approximately 5 square metres for the total area of the blades.

Again, taking type No. 6 for the same speed, the thrust $= \frac{75}{2.5} = 30$ kilograms per H.P., and the corresponding blade area $= \frac{30}{4.2}$, or about 7 square metres.

These are clearly much better results than any of the other forms tabulated would give us.

Whether the numerical results obtained in these small scale experiments will hold good in the case of larger propellers is, of course, somewhat doubtful, and can only be determined by repeating the tests on a much larger scale.

The author contends that in any case those forms which give the best results in these small screws ought to be the ones selected for further experiments.

With this object in view he has supplemented his first series by some additional tests. In these he has used screws with blades almost perfectly plane, the slight convexity serving merely to stiffen the thin sheets.

Each blade was attached to the central plate by a small bolt, so as to be adjustable at any angle to the normal plane.

The object of these tests was to determine the thrust and required H.P. when the blades were set at different angles.

The screw used is shown in fig. 9, and the mechanism for applying the power and for measuring the speeds, etc., was practically the same as in the preceding series of experiments.

The screw as shown weighs 1.58 kilograms (3 48 lbs.).

Its diameter = 1.028 metres (40.47 in.).

The radius of gyration = .315 metre (12.4 in.).

The blade area = .1123 square metre (1.21 sq. ft.).

The blades were first set at an inclination of 5° to the normal plane, and then successively at 10°, 15°, 20°, 25° and 30°, and the corresponding values of K, of $\frac{K}{F}$ and $\frac{U}{F}$ were measured for different rates of speed by the method explained above.

The results are summarized in Table II., which corresponds in form to Table I., given above. In this table α = the angle of inclination, the other symbols having the same meaning as in Table I.

TABLE II.

Velocity per Sec. of the Centre of Gyration.	Values of $\frac{K}{F}$, *i.e.*, Axial Thrust in Kilograms Produced by 1 Square Meter of Blade Area.				Values of $\frac{U}{K}$, *i.e.*, Power in Metre Kilograms per Second Required to Produce 1 Kilogram of Axial Thrust.			
	5 m.	10 m.	15 m.	20 m.	5 m.	10 m.	15 m.	20 m.
$\alpha = 5°$	0.40	0.98	1.63	2.70	5.00	5.56	6.25	6.60
$\alpha = 10°$	0.90	2.05	4.78	6.66	2.02	2.42	3.75	4.70
$\alpha = 15°$	1.07	2.80	5.68	....	2.20	3.28	5.10	....
$\alpha = 20°$	1.16	3.07	6.94	....	2.30	3.77	5.51	....
$\alpha = 25°$	1.33	4.67	....	....	3.50	5.80	....	....
$\alpha = 30°$	1.65	6.01	....	....	4.87	7.26	....	....

An examination of this table indicates, as might have been expected, that the thrust K increases rapidly as the angle α gets larger. The values of $\frac{U}{K}$ in the second half of the table, however, show that this increased reaction is obtained by a much larger expenditure of energy when α exceeds 20°.

For this reason inclinations of from 10° to 20° give the most efficient screws. This result might also have been predicted on theoretical grounds.

The air pressure, which, of course, acts normally to the blade surface, may be divided into two components, one of which (K) is the thrust parallel to the axis of revolution, while the other acts at right angles to the axis. This latter component produces a pressure of the journal on its bearing which grows rapidly with an increase in α, and thus adds largely to the power required to overcome the frictional resistance.

For different rates of speed the thrust for any given angle of inclination ought theoretically to vary as the square of the speed of revolution, and the power expended as the cube.

In practice the friction of the air on the blades vitiates the calculations at least for small angles of from $\alpha = 0°$ to $\alpha = 10°$, though for inclinations between 10° and 30° the tests agree pretty closely with the results obtained from the mathematical theory.

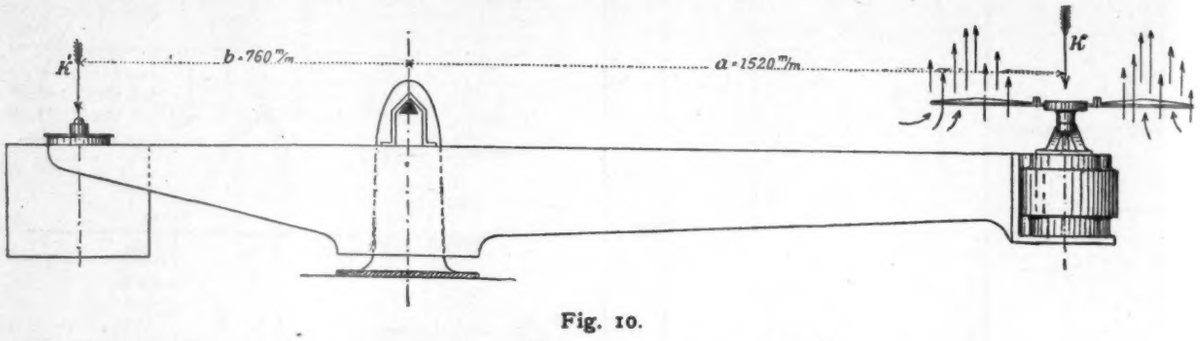


Fig. 10.

BALANCED LEVER METHOD OF WEIGHING POWER.

Hargrave's New Flying Machine.—We learn that Mr. Hargrave, of New South Wales, whose experiments with kites we illustrated last month, is now engaged in making the working drawings for a full-sized machine, to spread 480 sq. ft. of surface, to weigh 260 lbs., and to be driven by a 3 H.P. single screw. He expects to make a 10 minutes' run at first.

The Use of Captive Balloons at Sea.—The proceedings of the United States Naval Institute contain some interesting details which were communicated to the *France Aërienne* by Colonel Nicolas d'Orloff, concerning the search made from a captive balloon to try and discover the whereabouts of the ill-fated Russian warship *Rusalka*, which foundered with all hands in a storm in the Gulf of Finland. The transport *Samoyede* was fitted up to facilitate the ascent of the balloon. The expedition was under the charge of an officer and 25 soldiers of the aerostatic park of St. Petersburg. For 19 days the *Samoyede* was towed out from Helsingfors (Russia) every morning and towed back at night.

The balloon employed had a capacity of about 20,000 cub. ft.; it ascended to altitudes varying from 656 to 1,443 ft.; with a head wind it was towed at a rate of 2½ knots; with a favorable wind the speed was sometimes increased to 6¼ knots per hour. Two observers were constantly in the car and were relieved every three hours. Glasses were not used, as it was found that the naked eye could discern objects at the bottom of the sea much better than when artificial aids were employed.

The conclusions arrived at were as follows: That at a height of 1,300 ft. it was not possible to see the bottom of the sea to any great depth, in consequence of the impediments to vision offered by the color of the water and of the bottom. With a favorable light, rocks and sand-banks were clearly defined at depths of from 19 to 23 ft. Larger sand-banks could be seen according to the color of the water at a depth of 40 ft.

Observations from a captive balloon are more easily carried out at sea than on land, because the air currents are more uniform and are not so subject to sudden changes. Vessels can be distinguished perfectly, and there is no difficulty in recognizing whether they are merchantmen or men-of-war. Colonel d'Orloff concludes that captive balloons would be of great utility as observatories to a fleet, enabling the officers to reconnoitre the entrance of unknown harbors, and for ascertaining the exact position of forts, batteries, and other defences. In time of peace the balloons could be used in hydrographical researches.